ELEMENTARY TELEPHOTOGRAPHY

ERNEST MARRIAGE F.R.P.S.

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ELEMENTARY TELEPHOTOGRAPHY

BY

ERNEST MARRIAGE, F.R.P.S.

WITH ILLUSTRATIONS BY THE AUTHOR.

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LONDON:

ILIFFE & SONS Limited.

1901.

ILIFFE & SONS LIMITED, LONDON AND COVENTRY.

PREFACE.

At the present time there is no small English handbook upon the subject of telephotography, though the use of telephotographic lenses is spreading and seems likely to become general. This book is meant to serve two purposes—to show those who are unacquainted with telephotography the advantages gained by its practice, to help them in the selection of apparatus, and to assist telephotographers who often have no guide by which to determine their exposures. Most makers of these lenses furnish tables in their catalogues, but these are never sufficiently extended to be of much practical use, and do not always include any direct measure of the rapidity of the lens. I have sought to overcome this difficulty, and make my book of permanent use, by tabulating particulars applicable to all negative lenses (up to 6in. focus) by makers with whose names I am acquainted.

No attempt is made to explain or discuss the optical problems involved in the construction of telephotographic lenses; for full information the reader should refer to Mr. T. R. Dallmeyer's monograph, "Telephotography." I have freely consulted the book, and am also indebted to Mr. Dallmeyer personally for kind

assistance. Reference should also be made to the first "Traill Taylor Memorial Lecture," "On the Focometry of Lens Systems" (November 8th, 1898), by the same author, which embodies some important notes upon telephotographic lenses, including a means of ascertaining the focal length of a negative lens. Dr. P. Rudolph, of Jena, is the author of an interesting treatise which is obtainable in a translation. Whilst articles by several writers have appeared from time to time in the photographic press, I do not know of any other separate publications in the English language.

Mr. J. W. Cruickshank first made me acquainted with the powers of telephotographic lenses in 1894, and I am very greatly indebted to him for constant subsequent help and advice. I am under great obligations to Mr. J. H. Agar Baugh and Mr. W. B. Ferguson for the interest they have taken in the progress of this small book and for valuable suggestions with regard to it.

Most of the illustrations have appeared in *Photography* or in *The Photographic News*, whilst the three comparative photographs made in the abbey church of Vézelay are from *The Photogram;* to the editors of these three journals my thanks are due for placing the blocks at my disposal.

It is a pleasure also to record the generous assistance that I have received at the hands of lens

makers. Messrs. J. H. Dallmeyer, Limited, Voigtländer and Sohn, and Carl Zeiss have, by valuable loans of apparatus, enabled me to experiment with various types of lenses to an extent which would have been impossible but for their kind co-operation.

E. M.

South Woodford,
June, 1901.

Postscript.—Since this book has been in the printers' hands, Messrs. R. & J. Beck, Ltd., have published a pamphlet ("Practical Notes on Telephotography") which should be read by those who are interested in the subject.

E. M.

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Not infrequently in the text I have had occasion to mention the make of lens which was employed to take certain of the photographic illustrations; possibly it may interest some readers to have these particulars of the other examples. The table below of the lenses used will, in conjunction with the column headed "Lens" in the List of Illustrations, give full information on this head.

A Dallmeyer "Naturalist's" Hand Camera. Lens fitted: 1B Patent Portrait, 6in.; 3in. negative.
B Dallmeyer 2B Patent Portrait 8in.
C ,, ,, ,, ,, ,, 4in. negative.
D Ross-Goerz Anastigmat, 8¼in.
E ,, ,, 8¼in.; Dallmeyer 4in. negative.
F Ross's "Universal" symmetrical, 6in.; Dallmeyer 3in. negative.
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I ,, Anastigmatic Single 13¾in. (350 mm.)
L ,, Satz-Anastigmat 7in. (179 mm.); Zeiss Tele-negative 3in. (75 mm.), as shown in fig. 7.
M Zeiss Tele-positive 5¼in. (135 mm.); Zeiss Tele-negative 2¼in. (58 mm.), as shown in fig. 3.

CHAPTER I.

DEFINITIONS.

Camera Extension.—The distance from the face of the flange, into which the lens is screwed on the camera front, to the screen.

Distance from the Negative Lens to the Screen.—See fig. 1 C ; also page 102.

Equivalent Focal Length.—A term applied to a compound lens. It is the measurement of the distance between the focal plane (for parallel rays) and the optical centre of the lens-system (see note p. 26). It is called equivalent from being compared with the focal length of thin single lenses. Lenses of the same equivalent focal length give images of equal size of any given object provided that their focal centres are placed at the same distance from the object, though the distance from the lens or its diaphragm to the plate may differ. The size of the image produced in a pinhole camera depends solely on the exact distance of the pinhole from the centre of the plate, and can be made a ready means of determining the focal lengths of lenses by simple proportion. The equivalent focal length of a telephoto lens is obtained by multiplying the focal length of the positive lens by the particular magnification (see next page) employed.

Equivalent Aperture.—Multiply the f number of the stop in the positive lens by the magnification (see

below); the result is the equivalent aperture or intensity of the telephoto lens. The intensities of various stops (f/3·16, f/8, and f/9) with various magnifications will be found in the tables on pages 105 *et seq.*

F Number.—The diaphragms of most modern lenses are marked with a number expressing the relation the diameter of its aperture bears to the equivalent focus of the lens; these numbers are called f numbers. An aperture of f/8 is, roughly, a circle whose diameter is $\frac{1}{8}$ the equivalent focus of the lens, f/16 is $\frac{1}{16}$, and so on.

Front Lens.—See Positive Lens (fig. 1 A).

Intensity.—See Equivalent Aperture.

Magnification.—Throughout the book this is understood to be linear magnification. To find the magnification of a telephoto lens: Divide the distance from the negative lens to the screen by the focal length of the negative lens and add one, the result is the magnification.

Negative Lens.—The back lens of a telephoto combination (see fig. 1 B; also figs. 2 to 10a, etc.)

Ordinary Lens.—Also spoken of as a front or positive lens.

Positive Lens means an ordinary photographic lens.

U.S. Number.—Uniform system number (see page 103).

CHAPTER II.

TELEPHOTOGRAPHIC LENSES.

The main characteristics of telephotographic lenses, as far as photographers are concerned, are two.

They give photographs of objects on a larger scale than ordinary lenses will, with the same camera extension.

They are not of fixed focal length, and will give a sharp image at any camera extension (measured from the negative lens to the screen, see fig. 1 C) greater than the focal length of the front or positive lens.

A rough drawing of a telephotographic lens is given in fig. 1. It will be seen to consist of two parts—an ordinary photographic lens A, which may be a rectilinear (as here intended), anastigmat, portrait, or single lens; and B, a negative lens, either single, as shown, or double. This sketch has no pretensions to accuracy. For a correct idea of the forms of the various lenses, the reader should refer to the illustrations prepared by their makers, and kindly placed at my disposal.

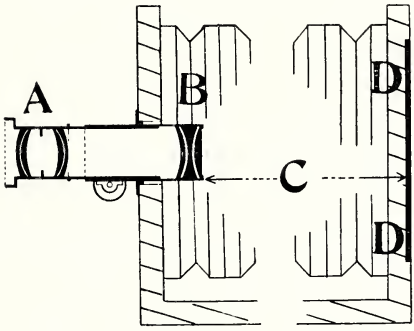

Fig. 1. Camera and Telephoto Lens.

The front or positive lens is generally an ordinary photographic lens. Any good lens with an aperture of f/8 is suitable, but if short exposures are necessary the aperture must be larger. The negative lens, unlike the positive lens, is by itself useless. A telephotographic lens is focussed by altering the distance between the front lens (A) and back lens (B) ; the shorter the camera extension the greater must be the separation of the positive (A) and negative lenses (B). The equivalent focal length of the telephoto lens can be ascertained from a careful measurement of this separation, and the exposure determined from that basis ; it is, however, easier in practice to find out the exposure from the distance between the negative lens and the screen (C in fig. 1), and I shall limit the scope of this little book to the latter method.

The focal length of the negative lens generally supplied is half or less than half the focal length of the ordinary (positive) lens to which it is fitted, and perhaps, taken all round, the proportion of one to two is the most useful. Where, however, great increase in size is not desired, as for example in ordinary landscapes, architectural work (where a wider angle of view is desirable), and some portraiture, there may be an advantage in using a negative lens of longer proportionate focus.

A negative lens whose focal length is much less than half that of the positive lens may be said to be of high power, and a negative lens of much greater focal length than half that of the positive lens as of low power.

A lens of high power increases the scale of the image

on the screen considerably with a small camera extension, but has small covering power.

A lens of low power does not greatly increase the scale of the image unless the camera extension is very great, but has good covering power.

Both statements are purposely exaggerated, and are intended only to show the direction of the faults in either extreme.

Another question than the fancy of the photographer places limits on the choice of lenses. In fitting a negative to a positive lens the greater the focal length of the former the nearer must the two be together, until at last, especially with a portrait lens for the positive, the two lenses cannot be brought sufficiently near to one

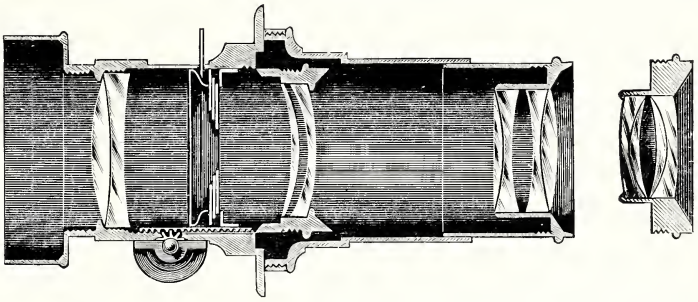

FIG. 2.
DALLMEYER MODERATE-POWER TELEPHOTO LENS.

HIGH-POWER NEGATIVE.

another to focus on any but a near object, or at a small camera extension. On the other hand, shortness of focal length in the negative lens compels greater separation of the two lenses. The gain in size brought about by the use of a negative lens of short focal length is, to a small extent, counterbalanced by the increased separation necessary, as, generally speaking, the extra length of tube required is inside the camera, and

reduces the available distance from the lens to the screen (C).

Taking first the more rapid type of telephoto lenses, such as shown in fig. 2, whose positive lenses are capable of use at an aperture of f/3·16, these are necessary to the telephotographer who wishes to take portraits, or snap-shot figure studies, to work in a poor light inside large buildings, or to photograph distant objects on as large a scale as is possible. A portrait lens if stopped down is almost, if not quite, as good for exterior architectural telephotography as a rectilinear or anastigmatic lens; it has, however, the disadvantage that, unlike the latter, it is not suitable for ordinary work (apart from the negative lens), and is besides, owing to its large aperture, a bulky lens to carry. The portrait lenses supplied by Messrs. Dallmeyer and Messrs. Voigtländer are provided with a special adjustment for flattening the field of the telephoto combination. Messrs. Dallmeyer achieve this by unscrewing the back cell of the portrait lens; Messrs. Voigtländer's lens is so contrived that by a scale and pointer on the outside of the lens the field of the combination can be flattened for the particular

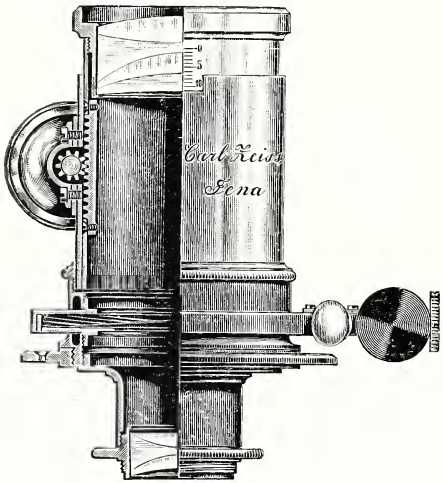

FIG. 3. ZEISS TELEPHOTOGRAPHIC TUBE-MOUNT III. (Scale $\frac{1}{2}$.)

camera extension employed. The latter is the more convenient and correct method, and gives very good results.

The "tele-positive" lens made by Messrs. Zeiss (see fig. 4) is a single cemented lens made up of four parts. It has two advantages over ordinary lenses of large aperture. It is less bulky, and, as it has fewer reflecting surfaces than a doublet or a portrait lens, the brilliancy of the image is greater. It is designed for all kinds of telephotography requiring rapidity, such as mentioned in the previous paragraph, but, unlike the ordinary form of portrait lens, it is not well suited to architectural photography,* as it gives marked curvilinear distortion at the margins of its field. If the camera extension is sufficiently great to bring the plate well within the circle of illumination, the distortion will not be apparent. Figs. 22, 26, 28/30 were all taken with this lens (and a negative lens). Only in fig. 30 is there any trace of the fault—the outer edge of the kiosk on the left will be seen to be slightly curved; the distance from the negative lens to the screen was in this case only 6½in., which is decidedly short for the 5 × 4 plate.

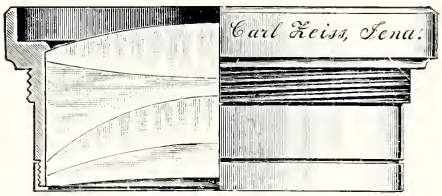

FIG. 4. ZEISS TELE-POSITIVE No. 1 (full size).

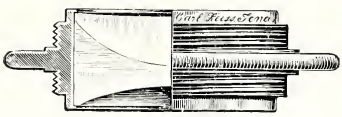

FIG. 5. ZEISS TELE-NEGATIVE No. 2 (full size).

The Dallmeyer-Bergheim is a very simple form of

* Messrs. Zeiss recommend for this branch of work their rapid anastigmatic lenses of Series II., IIa., III., IIIa., and VIIa.

telephotographic lens, consisting of two single lenses (see fig. 6), each lens being made of one piece of glass, not of cemented glasses as in the combinations already mentioned. It is intended exclusively for portraiture when the scale of the head is large. It is not corrected for chemical rays, and with full aperture does not give critical definition. To illustrate successfully the practical application of this lens would necessitate the use of large reproductions, which the size of the present volume will not permit. I do not therefore attempt to deal with it, but as the Dallmeyer-Bergheim is a telephotographic lens this chapter would be incomplete without some reference thereto.

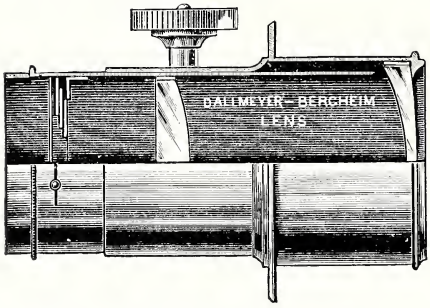

Fig. 6. Dallmeyer-Bergheim Lens.

Undoubtedly the amateur who intends to use a telephotographic lens for architecture, distant landscape, and seascape, will find in a rectilinear, or anastigmatic lens, the most suitable positive. Any maker of telephoto lenses will supply a negative lens to suit the requirements of an existing positive (*i.e.*, ordinary) lens of good quality; the aperture of the latter should not be less than f/8. If a complete telephoto lens of this type is required,

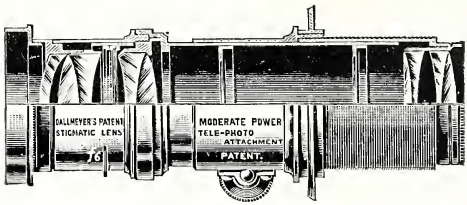

Fig. 7. Dallmeyer Stigmatic Lens with Telephoto Attachment.

the positive lens should preferably be composed of unlike single lenses,* as for example Messrs. Dallmeyer's "Stigmatic" Lens (see fig. 7), Messrs. Zeiss' "Satz Anastigmat" (see fig. 8). The advantage of a choice of three foci for ordinary work is great.

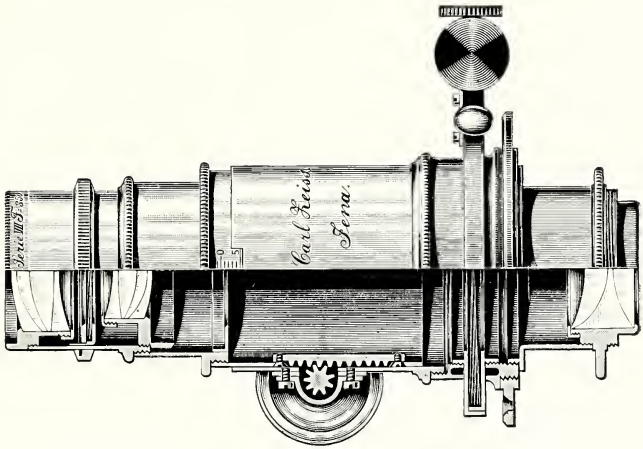

FIG. 8. ZEISS TELEPHOTOGRAPHIC LENS TUBE-MOUNT III. SATZ ANASTIGMAT 179 mm. and TELE-NEGATIVE 58 mm. (Scale $\frac{1}{2}$)

If the negative lens projects inside the camera to a distance equal to its focal length, and its focal length is in every case half that of the positive lens with which it is combined, the equivalent focal length of the telephoto lens is then always equal to twice the camera draw. Similarly, if the negative lens is one-third the focal length of the positive lens, the equivalent focal length will be three times the camera draw (not the distance from the lens to the screen). For example, take a camera draw of 15in.: Telephoto lens A, composed of 8in. positive, 4in. negative; telephoto lens B, composed of 6in. positive, 3in. negative.

*Most opticians now supply lenses of this description. I may also mention Messrs. R. & J. Beck, Messrs. Ross, Ltd., Messrs. Steinheil Söhne, and Messrs. Voigtländer and Sohn.

Telephoto A projects inside the camera 4in., the distance from the negative lens to the plate is therefore 11in., giving $3\frac{3}{4}$ magnifications (see Table II., page 105) and an equivalent focus of $3\frac{3}{4} \times 8 = 30$in., and with the positive lens at f/8 an equivalent aperture of f/30. Telephoto B projects inside the camera 3in., the distance from the negative lens to the screen is therefore 12in., magnification 5, the equivalent focal length $5 \times 6 = 30$, but the lens with a similar aperture, viz., f/8, will have an equivalent aperture of f/40. Telephoto lens A requires little more than half the exposure necessitated by the use of telephoto lens B. On the other hand, the distance from the negative lens to the screen, being greater with B, the smaller lens covers a 10 × 8, while A will only cover a whole-plate.

The conclusions drawn from this comparison are two, viz.: First, if rapidity is required the foci of positive and negative lenses (particularly the former) should be as long as possible; second, if duration of exposure is not of much moment there is an advantage in the use of smaller combinations.

The most generally suitable telephoto lens for snapshot exposures upon quarter or 5 × 4 plates is formed by combining an 8in. positive lens having an aperture of f/3·16 with a 4in. negative lens. A smaller combined lens reduces the size of the image, whilst much larger sizes are inconveniently bulky as well as expensive. The lens could also be used on a half-plate, under favourable circumstances, at an equivalent aperture of about f/16.

Bearing in mind the utility of an 8in. ordinary lens

for use with a half-plate camera, the same focal lengths (viz., an 8in. positive and 4in. negative) should perhaps be adopted by those whose subjects do not require very short exposures. Apart from the question of the use of the positive lens by itself on the half-plate, I prefer a telephoto lens composed of a 6in. positive and 3in. negative for that size camera, on account of its greater covering power.

Examples of negative lenses and suitable mounts for rectilinear and anastigmatic lenses are illustrated by figs. 2 to 10. Messrs. Dallmeyer make two forms of negative lens, both of them double, whilst all hailing from abroad are triple cemented single lenses. Greater freedom from distortion is claimed for the double form of lens; the single lens, on the other hand, having fewer reflecting surfaces, should theoretically give more brilliant images.

The type of mount may be varied to meet special requirements. For large lenses the type originated by Messrs. J. H. Dallmeyer, Limited (see figs. 2 and 7), is the most suitable, as the strain on the camera front is lessened by the diminished projection of the front lens, but the advantage is accompanied with a certain loss of magnification, as the available distance from the negative lens to the screen is lessened by the encroachment of the negative lens. Messrs. R. and J. Beck, Limited, in their "Beck-Steinheil" telephoto lens (see fig. 9), have adopted a similar construction.

If the lens is not large, or the camera front is strong enough to stand the extra strain, there is an advantage in the use of mounts such as seen in figs. 3, 8, and 10.

The negative lens only projects slightly inside the camera, and consequently rather higher magnifications are obtainable. Some telephoto lenses are focussed by altering the position of the negative lens. It is not a matter of much importance, but in use I think those with a fixed negative and movable positive lens are rather more convenient. Messrs. Voigtländer and Sohn (and possibly other makers) use a spiral rack and pinion in their tube mount (see fig. 10); this is an improvement on the usual pattern.

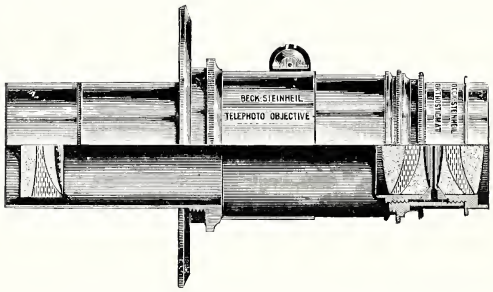

Fig. 9 Beck-Steinheil Telephoto Lens.

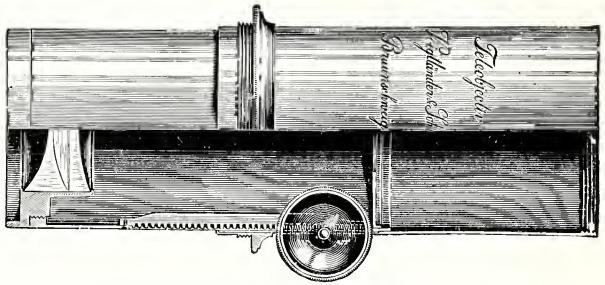

Fig. 10. Voigtländer Telephoto Attachment.

At the time of going to press Mr. Dallmeyer's latest telephotographic lens, the "Adon," is not available. It is therefore impracticable to include any examples taken with the lens, or to give any practical hints founded on personal experience. The following particulars may be of interest:

The "Adon" lens itself is a complete telephotographic lens of high magnifying power, and may be used alone if desired. Unlike other telephoto attachments, which are screwed behind the ordinary lens, the "Adon" screws into the front of the ordinary lens mount, in the position generally occupied by the lens hood. This feature of its construction makes it available for use in small hand cameras. The lenses of which it is composed, though the front or positive lens is necessarily of large diameter, are not weighty, and the settings will be made of aluminium for the sake of lightness. A sliding spiral movement will take the place of the usual rack and pinion, and the length of the attachment will be kept as short as is practicable.

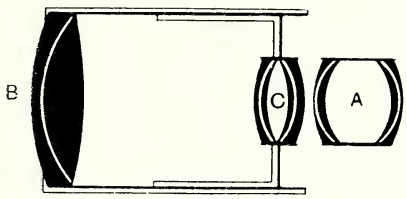

FIG. 10a.

The construction of the lens is shown in fig. 10a. The positive lens B is single, and of about the same focal length as the ordinary lens A to which it is adapted, but has a larger aperture, viz., f/4. The negative lens C is placed close to the ordinary lens, and its focal length is so adjusted that the combined focal length of the negative and ordinary lenses (C and A) is still negative. The complete system, as illustrated in fig. 10a, is similar in principle to the well-known types of telephoto lenses, in that it is composed of a front or positive lens (working at f/4) and a compound negative lens (C and A) of low power. Fig. 10a is a rough copy of one of

the diagrams in the patent specification (No. 24,720 of 1899).

The "Adon" lens is chiefly designed for use in hand cameras, and will probably only be sold in one size. The advantage which it possesses over previous telephoto attachments is in the substitution of a rapid lens in place of the ordinary rectilinear. If an ordinary lens with an aperture of f/8 is converted into a telephoto lens by the addition of a negative lens in the usual way, the combination, when it gives two magnifications, will have the equivalent aperture f/16. On the other hand, if an "Adon" lens is fitted in front of the same ordinary lens, the equivalent aperture for the same magnification will be maintained at f/8; in other words, it will work at four times the speed. As the aperture of the ordinary lens increases, the advantage attaching to the use of the "Adon" lens diminishes; it will not supersede existing forms of rapid telephoto lenses where the positive lens has an aperture of f/4 or f/3. It provides a ready means of increasing the size of a distant object without altering the camera extension, and, under certain conditions, without reducing the speed of the lens. The size of the image increases with the camera extension, and the rapidity of the lens diminishes in the same way as with ordinary telephoto lenses.

CHAPTER III.

TYPES OF LENSES AND WORK FOR WHICH THEY ARE ESPECIALLY SUITABLE.

Portrait lens, aperture f/3·16 or f/4, combined with a negative lens of more than half its focal length : Portraiture. Animal studies. Figure studies. Landscape (with or without figures). Snap shots. Architecture. Medical and surgical photography. Large birds. Sea and shipping.

Portrait lens, aperture f/3·16 or f/4, combined with a negative lens of half its focal length : Portraiture. Heads of animals. Small birds. Distant landscape. Snap shots. Architectural detail. Medical and surgical photography. Sea and shipping.

Portrait lens, aperture f/3·16, combined with a negative lens of less than half its focal length : Distant landscape. High architectural detail. Sea and shipping.

Short shutter exposures can be given with these lenses if the light is favourable and the magnification is not too great. *The term portrait lens* is here understood to include extra rapid rectilinear lenses, aperture f/4, and specially designed single lenses working at f/3 ; the latter are not, however, recommended for architectural telephotography.

Rectilinear or anastigmat lens, aperture f/5·6 to f/8, combined with a negative lens of more than half its focal length : Landscape. Sea and shipping. Architecture.

If the light is good, figures may be included in the landscape and a shutter exposure given, especially with a lens having the larger aperture. Ships at sea may be taken with short shutter exposures.

Rectilinear or anastigmat lens, aperture f/5·6 to f/8, combined with a negative lens of half its focal length : Distant landscape. Sea and shipping. Architectural detail.

Ships at sea may be taken with short shutter exposures.

Rectilinear or anastigmat lens, aperture f/5·6 to f/8, combined with a negative lens of less than half its focal length : Distant mountains. High architectural detail.

These lenses require about four to eight times the exposure needed by similar combinations to the portrait series above mentioned ; they are not as a rule suitable for taking photographs of moving objects, or for interior architectural detail. For exterior architectural telephotography they are preferable to portrait combinations, and if short time exposures are permissible they can be used for landscape work.

CHAPTER IV.

THE CAMERA AND ITS ACCESSORIES.

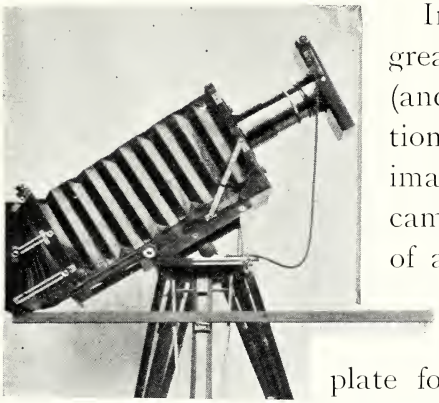

Fig. 11. Camera with Tilting Table.

In order to secure as great a range of focal lengths (and consequent magnifications of the size of the image) as possible, the camera should be capable of a fair amount of extension, say about three times the length of the plate for which it is designed. Triple extension is not desirable, as rigidity is sacrificed, and it is most essential to success in telephotography that the apparatus should be as firm and free from vibration as is possible. It must be borne in mind that the camera requires to be firm, not only at the ordinary focal length, but at its fullest extension, and with a comparatively heavy lens in the front. The older form of camera with parallel bellows (see fig. 12) is to be recommended; its front is stronger and better adapted to bear the weight of heavy lenses than that of the modern light landscape camera (see figs. 13 and 14).

A camera intended for use with ordinary lenses of great focal length requires to be rigid and strong, but

the optical construction of a telephotographic lens necessitates still greater stability, for the following reason: The optical centre* of an ordinary lens is situated within the lens mount (approximately), but the optical centre of a telephotographic lens is considerably in front of the combination. It will be familiar to most of my readers that if a lens is pivoted at its optical centre, it may be turned in any direction without moving the image upon the screen or plate, consequently such movement will not affect the sharpness of the image; this principle is made use of in panoramic cameras. It will also be found that the further the point of rotation is from the optical centre of the lens the greater is the movement of the image on the screen. It is very easy to test roughly the truth of these two statements in the following manner: Take an ordinary rectilinear or symmetrical lens, and suspend it by a string tied round the mount, close to the diaphragm; select any bright object, say a lamp, and place a piece of white card behind and in the focus of the lens. Now revolve the lens, and the image of the lamp will be stationary on the card. Next, take hold of the inner end of the lens between finger and thumb, focus the lamp as before, and twist the lens round with the free hand; the image of the lamp will now move as the lens turns. Vibration in the camera front may be loosely compared with twisting the lens backwards and forwards; in the case of an ordinary lens the rotation point is comparatively near

*Strictly speaking, there are two "nodal" or "Gauss" points which may be coincident, may be separated, or may cross. In ordinary language the optical centre of the lens refers to the nodal point of emission, and the distance of this from the focal plane is the measurement of the equivalent focal length. In telephotographic systems the "nodal" points of "admission" and "emission" are widely separated.

the optical centre of the lens; the movement of the image upon the screen is therefore only slight, and does not appreciably affect definition. With a telephoto lens the optical centre may easily be a foot or more beyond the positive lens, and the slightest tremor in the camera front must produce very marked movement of the image. If the movement takes place during exposure, naturally the definition of the negative is impaired.

For architectural work it is important that the camera back should have considerable latitude in the amount of swing, as the camera may very often have to

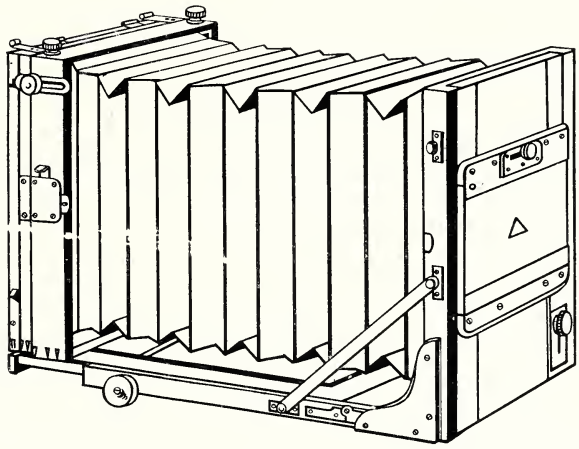

Fig. 12.

be tilted fifteen to thirty degrees, and the back brought to the perpendicular. In this respect the back, as generally fitted to the type illustrated by fig. 12, is very inadequate, even for ordinary architectural photography. With cameras of the type shown in fig. 13 the slotted stays project behind the back of the camera, and if the back is swung much out of the normal

position, they prevent the operator from drawing out the

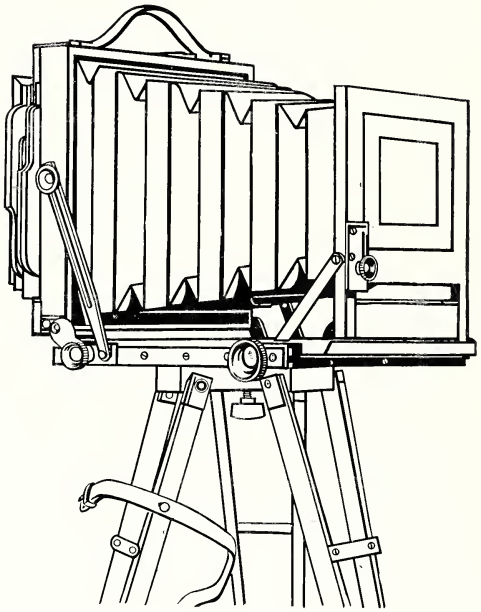

Fig. 13.

shutter of the double back for horizontal pictures. The pattern shown in fig. 14 is free from this defect.

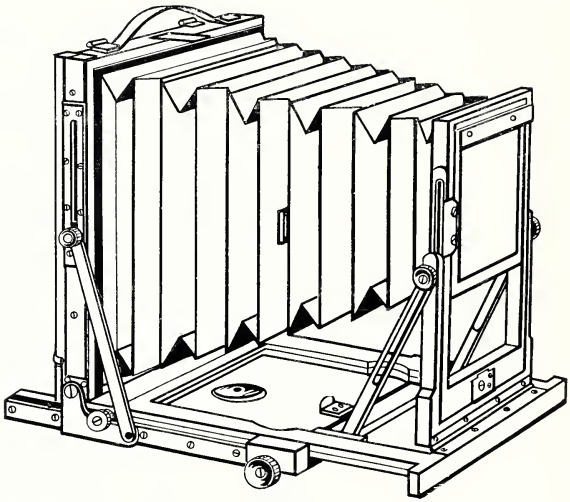

Fig. 14.

Another drawback to the use of cameras with conical bellows is the size of the front, which is generally too small to take the flange of a portrait lens of fair size.

It is quite practicable, however, to secure a very wide range in the swing of the back to cameras of the type in fig. 12, though some ingenuity is required to contrive a pattern that is capable of closing up entirely, *i.e.*, without awkward projecting brass stays. A sketch of such a camera is given in fig. 15; it is a $7\frac{1}{2} \times 5$ camera one-sixth natural size; the central stay C and its binding screw D are drawn separately one-third natural size. It

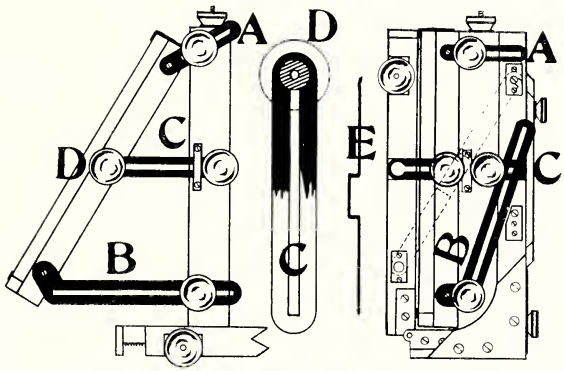

FIG. 15. THE AUTHOR'S CAMERA. (Scale about $\frac{1}{6}$.)

will be noticed that the slot of the stay C ends in a circular hole of a larger diameter than the width of the slot. The screw D has a shoulder (shaded in the separate sketch) which fits the hole accurately, but is a little deeper than the thickness of the stay. There is a sectional sketch of a similar screw D and stay C in fig. 18, which will further explain the construction. As the shoulder on the screw D is slightly deeper than the thickness of the stay C it (D) can be screwed home

without binding the stay C. By this means, when the camera swing-back is drawn out (as shown on the left hand, fig. 14) it is free to swing upon the central screw D, then when it is adjusted to the right position (generally, of course, the perpendicular) it is fixed by the binding screws on the stays A and B. The back is here swung to an angle of thirty degrees.

To close the camera the screw D is loosened until the shoulder disengages from the circular hole in the stay C, leaving the latter free to slide into the position shown in the drawing of the closed camera (to the right, fig. 15). The stay C lies in a groove in the side of the camera flush with the surface.

The support for the camera front E is dotted in, otherwise the sketch of the closed camera might be obscure; it must be crooked in the middle to clear the central screw D; a section drawing of E is placed beside the camera.

Throughout, the slotted stays are printed black. The lowest B, unlike the others, is not straight; the special shape is necessary in order that it may clear the stud on to which the support E fits when the camera is extended (as in fig. 12). If desired, the stay A may be of similar shape to B; the camera could then be pointed downwards and the back swung thirty degrees; but personally I have never wanted to swing the back in this direction as much as the straight form permits—a camera back built to this model is more rigid than other patterns—nor have I seen any other pattern affording equal facilities for swinging. The design is eminently practical; it is the outcome of some years of

experience, and embodies improvements which have occurred to several telephotographers.

I am frequently asked why such an amount of swing is required, when better definition is generally obtained by raising the lens and keeping the central axis of the lens at right angles to the plate than by tilting the camera and swinging the back. There is no doubt whatever that with any of the modern types of anastigmatic lenses the former is the better course, so long as

FIG. 16. THE SIGN-POST.

the lens will cover the plate, but it is useless to adopt this method to any large extent with telephotographic lenses, for the following reason: A telephoto lens only includes a small angle of view, and raising the lens would in the majority of cases move the circle of illumination off the plate. A reference to fig. 17 will explain this point. A B C D represents a photographic

plate, and the lens in use gives an image bounded by the circle E. It is obvious that when the lens is opposite the centre of the plate the whole of the plate is covered. But move the lens in any direction, then F will represent the position of the circle of illumination; the dark part of the plate in our diagram will not receive any image, and the resulting negative will show that amount of clear glass. If, however, the central position of the lens is maintained and the camera tilted to bring the image into position on the screen or plate, the conditions shown with the circle at E will be nearly maintained, even when the camera back is swung to the perpendicular—a necessary precaution if vertical lines in the object are to be shown as parallel in the negative. For architectural detail, such as the capital of a column illustrated on page 59, it will often be necessary to tilt the camera and swing the back from fifteen to thirty degrees. Those who have not tried it might think it well nigh impossible to secure good definition under such conditions, but as a matter of fact this difficulty does not often trouble the telephotographer.*

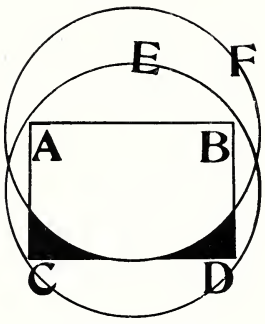

FIG. 17.

When it is desired to tilt the camera to any serious extent without interfering with the stability of the apparatus, a tilting table forms a necessary part of the

* "In these subjects where duration of the exposure is of no great moment, we can afford to employ almost the limit diaphragm for the combination, and in this case the pencils which form the image are so attenuated that it is possible to obtain fine definition even when the camera back has been considerably swung to obtain the true plumb."—T. R. DALLMEYER, "Telephotography," pages 134-6.

outfit. I have often seen it stated that a great increase of tilt can be given to a camera by bringing one leg of the tripod under the camera and placing its foot behind the other two; the plan is not, however, adaptable to all patterns of stands, and is at best only a makeshift. If a tilting table is in use it is perfectly simple to swing it round on the tripod top, and so to point the camera in any direction without altering the perpendicularity of the back of the camera, provided that the base of the table is levelled in the first instance. If the tilt is obtained by altering the position of the legs of the tripod any subsequent twisting of the camera necessitates readjustment of the legs, otherwise perpendicular and horizontal lines will not be parallel to the edges of the plate. The back of the camera must also be looked to; it will probably be out of the perpendicular. Apart from the question of tilting the camera for making telephotographs of details in architectural subjects, the tilting table is indispensable for work upon the roof or floor of a building. The best form of tilting table is shown in fig. 18; it is sketched in two positions. When only a moderate amount of tilt is required, the screws in the upper table are placed in the holes (one each side of the table) at A; by this means the camera may be tilted through all angles up to thirty degrees. For larger angles the

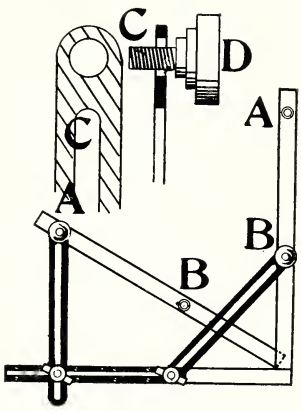

FIG. 18. TILTING TABLE.
(Scale about $\frac{1}{6}$.)

screws are placed at B, which completes the range of the table to ninety degrees. The upper screws and the supporting stays should be of the pattern shown, one-third natural size, in fig. 18 (D and C). The shoulder on the screw D (seen in section), next to the threaded piece, fits the circular hole in the end of the stay C, but as this shoulder is a trifle wider than the thickness of the stay C, the screw D can be screwed home without binding the stay. A similar contrivance is shown in fig. 15, but in that case the slot in the stay C ends in the circular hole. For the present purpose it is better not to have the slot and hole continuous. The lower clamping screws should be fitted with fly-nuts (as indicated); round nuts with milled heads are very trying to the skin of the fingers when they have to be frequently loosened and tightened. The hinges joining the upper and lower slabs of the table must be stout.

The tripod must also be selected for its strength and rigidity. For the past five years I have used a two-fold Ashford stand, with an 8in. top for half-plate and $7\frac{1}{2} \times 5$ cameras, and can strongly recommend that pattern. In any case it is well to order the tripod to suit a larger size camera than the one adopted, say a tripod for a whole-plate camera if work on the half-plate is contemplated.

In getting together a telephotographic kit, do not be afraid of weight; rigidity is one of the chief considerations if you would achieve success; lightness of the camera is of secondary importance. After taking every possible precaution to have the camera, tilting

table, and tripod as strong as possible, a gust of wind during an exposure, with the camera at a long extension, will sometimes spoil the definition of the negative. I think it more than probable that the disappointments which deter many photographers from using their telephoto lenses are brought about by tremor in a camera really too weak for the task imposed. The camera here described and illustrated, fig. 15, is suitable for any class of work demanding a stand camera, but if the photographer intends to confine his telephotography to landscape and portraiture there is no need to depart from the type of back seen in fig. 12. The user of a light camera with conical bellows is restricted in his choice of lenses, as the front is generally too small to take a fair size portrait lens. The internal diameters of flanges of two rapid telephoto lenses, with which some of my illustrations were taken, are $3\frac{3}{8}$in. and $3\frac{9}{16}$in., the focus of the portrait lens in each case being about 8in. The tilting table may be dispensed with, but is often useful for subjects other than architecture.

There are a few accessories which it is advisable to carry, viz., a measure, a spirit level, or a plumb line.

The measure is used for ascertaining the length of the camera extension, which must be known in order to calculate the working speed of the lens. A spring measure with metallic tape three or six feet long will answer all requirements and take up no room. These measures are frequently marked with inches on one side and centimetres on the other; it is often a convenience to have the French measure. The focal lengths

of some foreign makes of negative lenses are indicated in millimetres, and when this is the case it is easier to find the magnification from the measurement of the camera extension in centimetres. Those who prefer to adopt the metre for this purpose will find a suitable table at the end of this book. If preferred, a scale (or scales) can be made to form a part of the camera.

A very good form of spirit level is shown one-third natural size in fig. 19. The mount is of cast iron, accurately planed to a right angle. It should be used to level the camera, or if the short arm of the frame is placed flat against the screen of the camera it is easy to adjust the back until it is vertical. Small levels set in wood are sold for the same purpose, but they have neither the durability nor the accuracy of those mounted in metal. The level, of which this is a sketch, weighs between six and seven ounces; the sole advantage of a wooden mounting is the saving in weight.

I hope that the telephotographer will also include as an accessory a copy of the tables included in this volume. If these are not carried a substitute may be found in the "British Journal Photographic Almanac." In this annual a table of the uniform system number for stops (calculated by Mr. S. A. Warburton) is included; mount it on a piece of stout card and carry it in the camera case for reference. Without some such guide the correct exposure for an unaccustomed f value is a matter of guesswork. The photographer may know what is the correct exposure for, say, f/16, but not the extra length

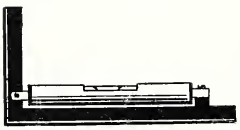

Fig. 19 Spirit Level. (Scale $\frac{1}{3}$.)

required with f/18. The exposure increases directly with the square of the f number, but it is best to avoid calculations as much as possible when busy photographing. A reference to the table will show that the respective exposures for the two stops should vary as 16 to $20\frac{1}{4}$.* On the back of the card which bears the table paste a piece of large clear print ; this is very useful if the camera has to be focussed on a dark subject or in a poor light.

In order that comparisons as to rapidity may be readily made between telephoto and ordinary lenses without pencil and paper, I have calculated the relative values (U.S. numbers) of all stops in ordinary use up to f/19, and include the table of these on page 103. The figures for f/20 to f/160 are incorporated in Table II.

*16 squared = 256, 18 squared = 324. The proportion between 256 and 324 is the same as between 16 and $20\frac{1}{4}$.

CHAPTER V.

GENERAL APPLICATIONS OF TELEPHOTOGRAPHY.

FIG. 20.
A SEAT ON THE EMBANKMENT.

Probably the greatest number of amateur photographers devote their attention almost exclusively to landscape work, and for ordinary every day scenery, such as is to be found in most parts of England, the ordinary lens—or if greater focal length is desirable, half of it—is more generally useful than a telephoto lens. Pretty bits of lane scenery, picturesque cottages, small streams or becks with wooded banks, are in themselves unsuitable subjects for the telephotographer. There are of course exceptions, but as a general rule it is impossible to include a sufficiently wide angle of view, or to get far enough away to combine all the essential features of the scene in the telephotograph. The experience gained in attempting such subjects is, I think, valuable. Even if the telephotographs are failures, much may be learnt in this way of the value of simplicity—a first essential to pictorial success.

The narrow angle of view obtainable compels the telephotographer to pay especial attention to the requisites of his composition, to the exclusion of needless surroundings, whilst the power of altering the scale of the image enables him under suitable conditions to include the exact amount of the subject that the composition demands. He obtains on the spot a direct result, which the ordinary photographer cannot equal by making enlargements from parts of smaller negatives. Technically there can be no doubt as to which method gives the finer result, but pictorially also the advantage rests, I am convinced, with the telephotographer.

Fig. 21. The other Man.

The wider the landscape, the greater should be the focal

Fig. 22. By Broxbourne Bridge.

length of the lens with which the view is taken. For such subjects the telephoto lens has decided advantages; this

is proved by the frequency with which such telephotographic illustrations occur in modern books of travel.

Fig. 23. A Drinking Fountain.

Unless the telephotographer is working in a district with which he is thoroughly acquainted, when he may know the most suitable positions from which to take the particular distant subjects, either the views will be "purely topographical" or he will have to walk over a considerable range of country, unless by a happy chance he arrives at the right place at the right time of day. It is obvious that to alter materially the general arrangement or lighting of a distant view, the position

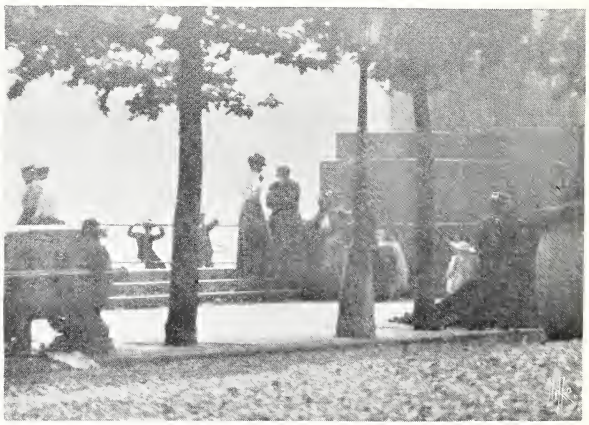

Fig. 24. Waiting for the Steamer.

of the camera must vary greatly. In an ordinary near view all possible variations may be obtained by walking round the subject on the circumference of a circle whose radius is, say, fifty yards, a total walk of 314 yards, but at the distance of half a mile, a walk of over three miles

Fig. 25. The Watercart.

is required for the same purpose. I chose one afternoon the point of view for taking a telephotograph of a certain church tower, but when the view was taken the following morning it was from a spot a quarter of a mile away from the place originally fixed upon. With such subjects a distance of a few yards has no appreciable effect upon the arrangement of the picture

The difficulties which beset the landscape telephotographer are chiefly atmospheric. Strong wind, by setting up a vibration in the long extension of the camera bellows, is an obvious danger ; this tremor can be minimised by using a box camera of more or less fixed focus, and having a selection of negative lenses to enable the magnification to be changed at will.

With a strong ordinary camera of the type shown in fig. 12, or with the special pattern, fig. 15, telephotographs may be taken under most ordinary conditions. A rapid type of lens, which makes a shorter exposure possible, is also a palliative.

Mist or haze will frequently stop all work of this character, though the use of a yellow screen and an orthochromatic plate may make it possible. For distant landscape an orthochromatic plate and properly adjusted screen ought, in fact, always to be used.

Dr. Rudolph writes :* " In outdoor photography the state of the atmosphere has generally an important influence on the quality of the picture. If the air be thick and hazy the negative will be lacking in crispness. Any tremor or variation in the density of the air intervening between the scenery and the lenses materially affects their definition." And again : " Water vapour, dust, and other impurities floating in the air are apt to spread a general haze over the picture, and, as we pointed out previously, air currents and the tremor of the atmosphere caused by oscillations of temperature greatly interfere with the defining power of the objective. . . . . Failures may occur if a photograph be taken of a landscape or of buildings through a window from which a current of the warm air of the room is passing, and the same happens if the hot air above a chimney should rise between the objective and the object. Success in telephotography therefore depends very often upon extraneous circumstances, and even

* " A Monograph on the Nature and Application of Telephotographic Objectives," by Dr. P. Rudolph, Jena. (English translation.)

with the greatest care it is not always possible to avoid failures. Landscapes and distant buildings should therefore be photographed only when the air is calm and clear, but hot days should be avoided."

"The influence of unequally heated air can easily be illustrated by a simple photographic experiment, which may be made indoors. Take a photograph of an engraving or etching, after carefully focussing, and you will probably obtain a fine negative. Repeat the

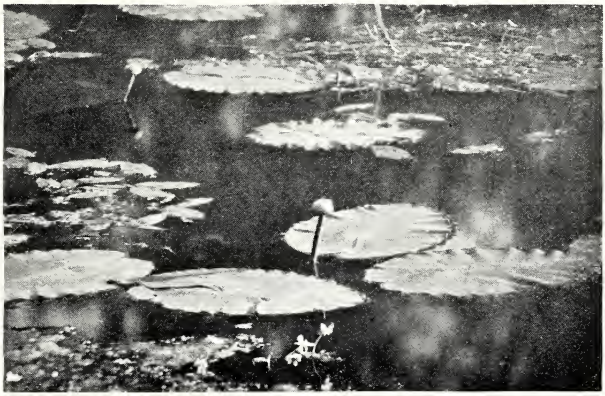

Fig. 26. Yellow Water Lilies.

experiment, without making the slightest alteration in your adjustments, but on the floor, between the object and the objective, place a lighted candle. The result will be a partly or entirely blurred negative. The explanation of this experiment lies in the variation of the density of the air caused by the rising heat of the candle."

In an article by Dr. E. J. Spitta which appeared in *Photography* (March 23rd, 1899, Vol. xi., p. 181) this

difficulty is mentioned, and the author states that telephotographs of distant landscape, or rather perhaps distant mountains, are most likely to be successful if taken in the early morning.

There are not the same difficulties in the telephotography of near objects ; the clearness of the day, except in the shortening of exposures, exercises comparatively little influence upon negatives of architectural detail, portraits, or figure studies combined with landscape. The application of telephotography to figure studies is a field hitherto practically untouched. As a rule the figures " introduced " into photographic landscapes

Fig. 27. Evening and a dusty Road.

(also to a great extent those in drawings and paintings) are wooden and self-conscious, and with ordinary lenses it is difficult to prevent this because of their necessarily close proximity to the figure. Animals other

than man are also self-conscious, though with less reason, as they are unable to understand photographs, and the real aim of the performance does not trouble them. With a suitable telephotographic lens it is generally possible, owing to the increased distance permissible, to take photographs of people at unconscious moments; the stiff awkwardness of the posed figure is then abolished, and men or animals harmonise with their surroundings. Snapshots of street scenes can often be taken with a stand camera more readily than with one carried in the hand. All the illustrations to this book are from stand camera negatives, including some which were taken with one of Messrs. Dallmeyer's naturalist's hand cameras. These (see figs. 20 and 21, 22 to 25) are five out of eight exposures made one afternoon along the Embankment. The watercart was photographed from the middle of the road, but for all the others the camera was standing upon the edge of the pavement on the opposite side of the Embankment. Fig. 27, "Evening and a dusty Road," is reproduced the original size, and was taken with the same apparatus. Without going so far as to say that with an ordinary lens such a photograph could not be made, it will be admitted that its performance would

Fig. 28. A quiet Haven.

require a certain amount of "nerve" on the part of the photographer, and might lead to a subsequent altercation with the driver of the trotting horse.

The banks of rivers offer favourable chances for the telephotographer. Figs. 22, 28, and 29 were taken from

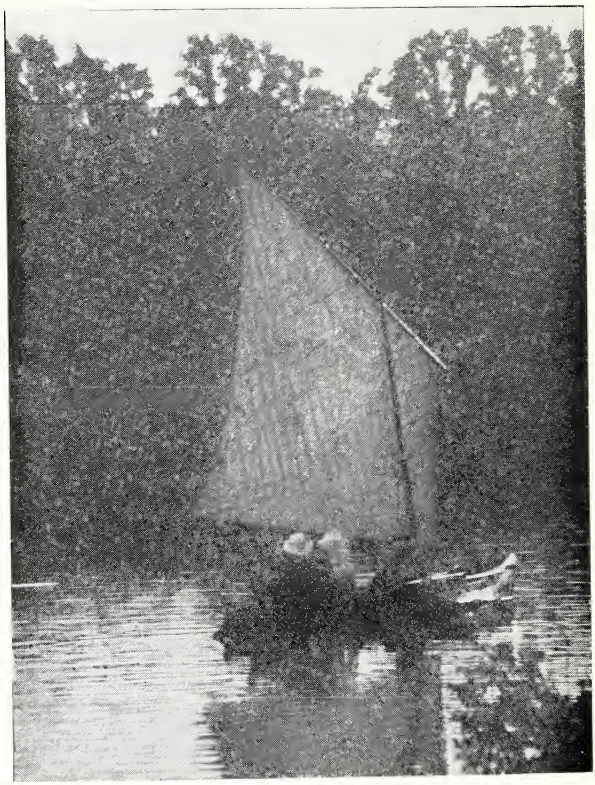

Fig. 29. Evening.

the banks of the Lea near Broxbourne, with an ordinary stand camera. But apart from such subjects as these, water plants can be conveniently photographed in their natural surroundings. For the photographing of land

flowers, ordinary lenses will as a rule be found more convenient, though there is always a distinct advantage in the use of telephotography if these subjects are taken, as they should be, *in situ*. A comparison of the results obtained by an ordinary and a telephoto lens in such work will be found in Chapter VII.

Clouds in a telephotograph are rarely prominent, partly, no doubt, owing to the general inconspicuousness of horizon clouds, nor are telephotographs of higher clouds in my experience successful; the angle of view is too small as a rule to give a good idea of the sweep of a cloud.

It is a common remark that telephotographs show better perspective than other views taken with ordinary lenses; this is true, if both photographs show the object the same size, and the object lies in more than one plane. Illustrations 31 and 32 are views of the same capital taken, the first with a telephoto lens, and the other with an ordinary lens. My aim in taking these two exposures was to get the images as nearly as possible the same size, but, as fig. 32 is on a somewhat larger scale, the perspective is a little more exaggerated than if the condition had been strictly fulfilled. On comparing the two photographs it will be apparent to all that fig. 31, the telephotograph, is truer to nature; the carved capitals are shown of nearly equal width, measuring down the edge of the angle between the heads of the grotesques and the angle between the two capitals. Similar measurements of fig. 32, the ordinary photograph, show a marked disproportion in size; the capital no doubt is the same height throughout. Had

the subject been of greater depth from front to back, the comparison would have been still more favourable to the telephoto lens.

On the other hand, there are people who object to telephotographs, on the ground that the idea of distance is largely lost, because parallel lines, walls of buildings, etc., do not converge so rapidly from the foreground as

Fig. 30. Boulevard in Sunlight, Angoulême.

is the case in photographs taken with lenses of shorter focal length. A reference to fig. 30 will graphically answer the objection; the long line of wall diminishes in height imperceptibly. Looking at one end, and comparing it with the other, it is evident that the size has altered, but though the difference is slight, the idea of distance is adequately expressed. In a fairly large collection of telephotographs I can only find one or two examples to which such exception could reasonably be

taken. In fig. 20—a small group on the Embankment—the buildings seen above the wall are across the Thames, and the space between the banks appears less than in nature; the half-tone block rather conceals the defect by reducing the brightness of the buildings, but it is very pronounced in a print or lantern slide. I think the black mass of wall, cutting out a large portion of the middle distance, is the cause of the defect, and that the composition, not the telephotographic lens, is to blame.

CHAPTER VI.

ARCHITECTURE.

I am inclined to consider the application of telephotography as of greater importance to the student of architecture than to photographers interested in other classes of subject. No doubt greater experience of this branch of telephotography biases my judgment, but in support of this opinion it may be confidently stated that there are here fewer impediments to success than

Fig 31. Capitals, Loches (Telephotograph).

in the case of portraiture or landscape. Exposures do not have to be reduced to, or below, the minimum to avoid danger of motion on the part of the object, nor, as a rule, does mist or haze in the atmosphere interfere with the work of the photographer.

There are many details about public buildings which cannot be taken upon a sufficiently large scale with ordinary lenses, or require staging to enable the camera

FIG. 32 CAPITALS, LOCHES. (Ordinary photograph from a near standpoint.)

to be brought sufficiently close to them. The capital on the proper right of the north doorway to the Church of St. Ours, at Loches, shown in fig. 33, is an example of a subject that cannot be easily and satisfactorily photographed on a reasonably large scale with an ordinary lens. The column is not high enough to

make this impossible (on page 51, fig. 32, is a photograph of this capital taken with an ordinary lens), but it is decidedly awkward to photograph, and the result so obtained is not equal to the telephotograph, the taking of which presents no difficulty. The general

Fig. 33. North Door, Loches.

view, fig. 33, was taken with a 7in. Zeiss-Satz anastigmat (f/22, exposure three seconds); the view of the

column, fig. 34, with the larger single lens of this combination, focal length 13¾in. (f/22, exposure four seconds); fig. 31, with the Zeiss 7in. lens, combined with a 3in. negative lens, magnification 5·6, equivalent focus 39·2in.

Fig. 34. North Door, Loches.

(equivalent aperture f/61·6, exposure two minutes twenty-five seconds). All three photographs were taken from the same spot, and the camera extension

in the case of figs. 31 and 34 was identical. The gain in size due to the use of a negative lens (forming with the same ordinary lens a telephoto lens) is seen by comparing figs. 31 and 33, whilst figs. 31 and 34 show the advantage possessed by a telephoto lens over an ordinary long focus lens, viz., increased size of image, or greater equivalent focal length, with the same extension of the camera. The exposures given for these examples were not theoretically correct. Figs. 33 and 34 should have received the same exposure; putting this at four seconds, then fig. 31 should have received rather more than two minutes five seconds.

It will be noticed that the telephotograph fig. 31 is dark at the corners; the fault is caused by want of covering power, brought about in this instance by improper use of one of the diaphragms with which the lens is fitted. The aperture of the diaphragm shutter, which forms part of the mount of the telephoto lens supplied by Messrs. Zeiss, was closed to such an extent, at the time of making the exposure, as to cut down the field of view. Instead of looking at the image on the screen to make certain that the plate was covered, I closed the diaphragm shutter, until, upon looking through the lens from the back, this opening appeared only a trifle larger than the diaphragm in the positive lens. This method of procedure had been in use for some few days when I happened to look at the ground-glass after the final adjustment, and saw the error, too late to save some telephotographs, but in time to prevent its further recurrence. Until this diaphragm was partially closed the image on the screen was complete to the corners of

the plate. Needless to say, no blame attaches to the makers and designers of the lens. I mention this to prevent others making the same mistake.

This fault in fig. 31, however, serves to show the importance of seeing that the telephoto lens does really cover the plate in use. The covering power of a telephoto lens is small if the camera extension is not long, and varies somewhat with the type of the ordinary or positive lens, also with the proportion between the focal lengths of the positive and negative lenses. Messrs. J. H. Dallmeyer, Limited, give the following figures in their list for a moderate power negative lens attached to a rectilinear lens:

Plate	covered	at	*full*	aperture	f/8	$4\frac{1}{4}$	×	$3\frac{1}{4}$,	back	focus	required $6\frac{1}{2}$in.
,,	,,	,,	,,		5	×	4,	,,	,,	,,	$7\frac{1}{2}$in.
,,	,,	,,	,,		$6\frac{1}{2}$	×	$4\frac{3}{4}$,	,,	,,	,,	$9\frac{1}{2}$in.
,,	,,	,,	,,		$8\frac{1}{2}$	×	$6\frac{1}{2}$,	,,	,,	,,	13in.
,,	,,	,,	,,		10	×	8,	,,	,,	,,	$15\frac{1}{2}$in.
,,	,,	,,	,,		12	×	10,	,,	,,	,,	$19\frac{1}{2}$in.
,,	,,	,,	,,		15	×	12,	,,	,,	,,	$23\frac{1}{2}$in.
,,	,,	,,	,,		18	×	16,	,,	,,	,,	29in.

Stopping down the front lens reduces the covering power of the combination; care should therefore be taken that the back focal length (*i.e.*, the distance from the negative lens to the screen) is ample, otherwise the use of a smaller stop may mean that the negative will vignette into "bare glass" at the corners. The telephoto lens must also be opposite the centre of the plate if the latter is to be covered with the minimum of camera extension. Raising or lowering the lens will have a similar effect upon two corners, as has previously been shown.

Another reason for working with ample extension of

the camera is that with most telephotographic lenses there is curvilinear distortion near the margins of the field; if, however, the circle of illumination is well beyond the corners of the plate that is employed, this distortion will not be noticeable. The fault is not easily detected in most classes of subject, but requires

Fig. 35. Detail, Parma Baptistry.

care when dealing with details in architecture. There is slight curvilinear distortion visible in fig. 35, though the defect is not pronounced.

It may often happen that the telephotographer finds his lens is not covering the plate, and yet he is debarred from obtaining greater covering power by the fact that greater camera extension makes the image too large for the plate. To circumvent this difficulty the camera must be moved further away from the object; then, in order to increase the size of its image (the image now

being smaller as the object is further off) more magnification must be employed; the camera is extended further to achieve this, and the plate is covered without further trouble. If space is limited, and it is not practicable to move the camera, the best course is to give up telephotography for the time and use one combination of the ordinary rectilinear lens.

Apart from the value of putting space between the camera and the object in the above-mentioned case, there is a distinct improvement in the rendering of the object. The perspective in the photograph of such an object as the capital from the Church of St. Ambrose,

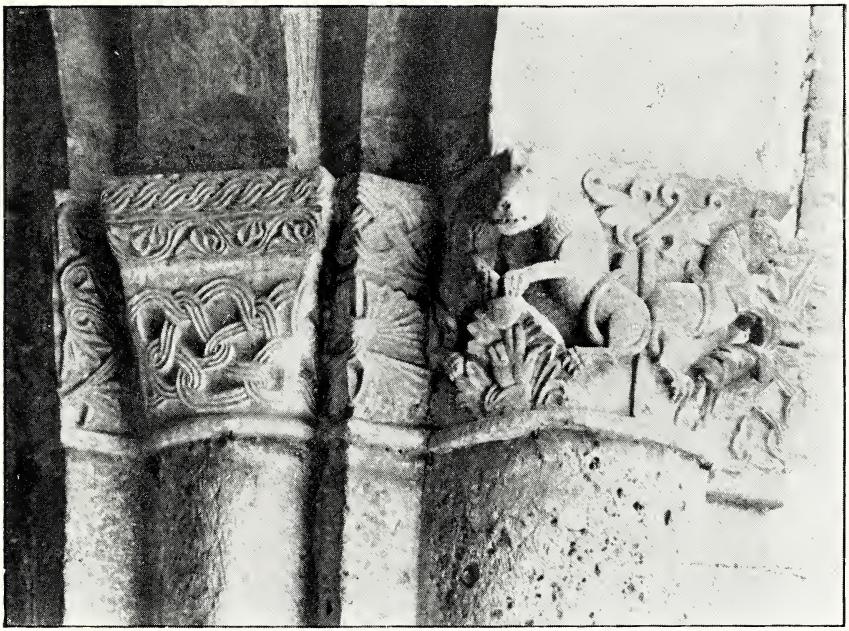

Fig. 36. Capital in the Atrium, St. Ambrose, Milan.

Milan, fig. 36, is unsatisfactory if the camera is placed near to and beneath it; the undersides of the carving obtain too great prominence until, in an exaggerated case, nothing else is visible. The observer naturally steps back, if he is close to the column, to view the

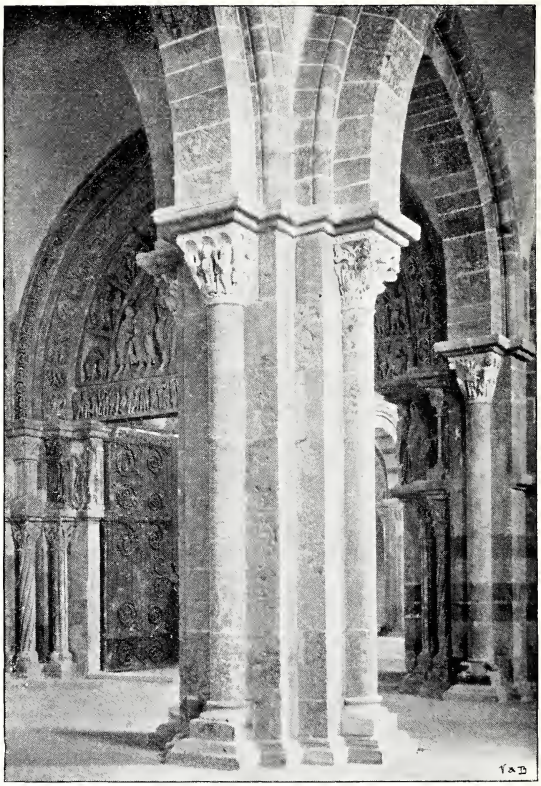

Fig. 37. Across the Narthex, Vézelay.

capital favourably, and the man with the camera must do the same. The photograph of the capital at Loches, taken with a 7in. lens from a near standpoint, may be referred to in this connection (page 51).

The kind of camera and the necessity of a tilting table for architectural telephotography have been dealt with already. To emphasise the need, two examples of the telephotography of fairly inaccessible objects are included among the illustrations. The capital from

FIG. 38. CAPITAL IN THE NARTHEX, VÉZELAY. (See The Acts xxi., 10 and 11 verses.)

Milan (fig. 36) referred to in the last paragraph is supported on a pillar about fifteen feet above the floor level, and the camera was distant thirty feet from the

base. By means of a tilting table the camera was tilted eighteen degrees, and the back was swung to the perpendicular.

The position of the capital shown in fig. 38 is seen by referring to the photograph taken with an ordinary lens (fig. 37). All three photographs were made from the same spot without altering the tripod in any way, the distance from the base of the tilting table to the floor was 4ft. 8in., and the camera was 32ft. away from the column. The tilting table was used to a moderate extent. When the telephotographs (figs. 38 and 39) were made, a tilt of sixteen degrees was requisite, and the camera back was swung to the perpendicular. All three photographs are equally reduced in the blocks, and for comparative purposes figs. 39 and 38 show the smallest and largest magnification which is practicable with the lens and camera employed; between these limits the choice of size rested with the photographer—the range of useful magnifications was from three in fig. 39 to five in fig. 38.

Fig. 39. Capital in the Narthex, Vézelay.

No ordinary enlargement of five diameters would give as sharp an image as the telephotograph. Let anyone

who doubts this statement try enlarging a quarter-plate up to 20 × 15. I have repeatedly tested the truth of this claim by enlarging on to transparency plates, but have never been able to produce an enlargement that was as sharp as even a moderately good telephotograph. An obvious advantage in the case of a telephotograph is the entire absence of the enlarged grain of the silver image which must be present in an enlargement made from a negative in the ordinary way.

I generally find that if there is any telephotography to be done at all, there are a good many plates to be exposed, and that therefore it is well when setting up the camera before a building to include the tilting table, and as it can be shut quite flat with the camera in position, it does not interfere with ordinary exposures. After selecting the subject and the point of view, the first step is to set up the tripod. Do not attempt to tilt the camera by altering the legs of the stand; arrange these so that the base of the tilting table is perfectly level; endeavour also to have the camera as firmly supported as possible. In the absence of wind, it will be found that the camera is less liable to move when the legs of the tripod are fairly close together. A breeze necessitates having a wider base; the legs should then be arranged so that one points windwards. It is sometimes an advantage to tie the legs of the tripod together with a continuous piece of string.

The camera is now supported upon the tilting table and tripod, with the telephoto lens in place, as seen in

fig. 11.* Rack out the camera to the minimum extension (measuring always from the back of the negative lens to the plate) required for the plate that is to be used. Focus the lens, by the pinion on the mount, on any subject that may be about the same distance from the camera as the piece of detail which is to be telephotographed. Then swing the tilting table and camera round on the tripod head until the lens is pointing towards the object. By means of the tilting table, tilt the camera until the image of the object is visible about the centre of the screen, and fix the table in this position. Focus the image by means of the pinion on the lens. If the details are now satisfactory in point of size and position on the plate, adjust the camera back until it is perpendicular, and re-focus upon the centre of the plate. The easiest way to adjust the swing back of the camera represented in fig. 15 is to loosen all the stay screws on the camera, and whilst keeping the top of the back against the frame, to draw out the bottom until the back has passed the perpendicular position; then clamp the central stays C on each side by means of the central screw on the frame of the camera. The back can now be rapidly adjusted, and when perpendicular, firmly held in that place by means of the screws on the stays A and B.

More generally, the image on the screen is not the most suitable size; if it is too small, all that has to be done is to increase the extension of the camera, and

* Drawings of this camera were published in *The Photogram*, January, 1898. A further modification, the crooked stay, was embodied in a sketch which appeared in *The Photographic News*, June 1st, 1900. The design in fig. 15 is superior to both. To Mr. J. H. Agar Baugh the credit of the first application of the crooked stay and the special central stay with a circular hole is due.

focus now and again with the lens until the desired end is attained. If, on the contrary, the whole of the object is not visible on the screen, the camera must be racked in until, on focussing as before with the lens, it is all included. When the camera extension is reduced, care must be taken that the plate is properly covered. There is no such risk when increasing the camera draw; there is then, however, greater danger of vibration, because of the greater surface exposed to wind, greater spring in the camera framework, and also a longer exposure in which vibration may be set up.

There are two difficulties that combine to make focussing awkward under some conditions. In the first place the equivalent aperture of a telephoto lens is not so large as that of most ordinary lenses. If the photographer is using his rectilinear for the positive lens with an aperture of f/8, then with a moderate number of magnifications, say four, this is reduced to f/32. On a well-lit object it is comparatively easy to focus with f/32, or a smaller stop, but in a diffused light, which is more suitable than strong sunlight, the process requires care, whilst interior work is always attended with more or less risk. If it is possible to affix a piece of large print upon the object this will prove of very material assistance; 2in. squares of black paper pasted on to a piece of white card would answer the purpose equally well; some people might even go so far as to include a diagram or measure of this kind (say 2in. black squares with 2in. spaces) in the negative. Secondly, it is not quite so easy to focus with a lens of long focus slight movements of the screen have less

apparent effect than in the case of lenses of ordinary focal length. With telephoto lenses at a moderate magnification the camera screen may be racked in and out to a considerable extent without much visible effect, and the golden mean of sharp focus is not easily found in this way. Under ordinary conditions it is better to focus with the rack and pinions on the telephoto lens itself; a slight turn of that pinion has a more marked effect upon the sharpness of the image. The question whether it is desirable to focus the telephoto lens with the particular stop that is going to be used for making the exposure depends to a great extent upon the positive lens in use. Some lenses when used in the ordinary way require to be focussed separately for different stops if the sharpest definition is required. If such a lens is used for the positive of a telephoto lens it becomes necessary to focus with the stop which will be used for the exposure. It is generally more convenient to focus with the full aperture of the lens and then to stop down until sufficient depth of focus is obtained. I have worked with a number of different types of telephoto lenses and found little or no need for departing from this method.

The next point to consider, after the image is focussed and arranged upon the screen, is the stopping down of the front or positive lens. If the camera has been tilted and the back swung appreciably it is certainly wise to use a small stop, f/22 or f/32, but if there has not been any great departure from normal conditions, probably f/16 will be ample. With a fair number of magnifications there is less need for stopping

down than when the lens is used to almost the full limit of its covering power. The depth of focus required by any particular object must be obtained by stopping down, as in the use of ordinary lenses, but it will not be necessary to quite the same extent. Theoretically the equivalent aperture of the telephoto lens should not be less than f/71 ("Telephotography," T. R. Dallmeyer, p. 86), but practically this limit need not be considered. I have repeatedly worked with such lenses at f/120 to f/160 and obtained negatives with sharp definition. Some lenses require to be stopped down to overcome curvature of the field—a defect that perhaps applies more to telephoto lenses in which the positive lens has a flat field than those in which a rectilinear possessing some curvature is employed; the latter counteracts reverse curvature set up by the negative lens. Some portrait lenses (Messrs. J. H. Dallmeyer's B patent portrait and Messrs. Voigtländer and Sohn's rapid telephotographic lenses) have an adjustment by which spherical aberration can be increased in the positive lens to counteract the reverse curvature inherent in the negative lens employed; the correction should vary with the extension of the camera.

The necessity for tilting the camera, and consequent swinging of the camera back, may often be partially removed by taking the telephotograph from a greater distance, and obtaining increased size by increased magnification. Swinging the back must always be considered as an evil, demanding the use of a smaller stop than would otherwise be required, and unless the

subject be on a level with the camera the advantage of being further away from it is great, if the pictorial result of the telephotograph is taken into account. The drawbacks are the extra extension of the camera, which can be somewhat lessened by the use of a negative lens of shorter focus, and the unavoidable diminution in the equivalent aperture of the lens due to increased magnification.

There are certain circumstances under which telephotography is unlikely to give pleasing prints, where an ordinary photograph, perhaps on account of its smaller scale, may be satisfactory enough. If an object is principally in deep shadow and with small brightly lit portions, an ordinary photograph will give a fair idea of the subject considered as part of a general view; but the telephotograph increases the area of the shadow, and the print is black and flat, with insufficient proportion of high light to give relief. It may be that fuller exposure would remedy the defect; at any rate it could do no harm. I remember particularly two sets of negatives which are examples of this variety of failure. The first is of some details on Strasburg Cathedral, upon the north side; the general view, taken with an 8in. lens, received twenty seconds exposure, with stop f/44, and the negative is as good as one could wish; the telephotographs, taken with an equivalent aperture of about f/46, were exposed from eighty to a hundred seconds. Generally speaking, the correct exposure for a telephotograph is the duration required by the ordinary lens multiplied by the square of the magnification, assuming that the stop in the

positive lens is the same in each case. With these examples, allowing for the use of f/11 in the case of the telephotographs as against f/44 for the ordinary work, the correct exposure should have been twenty-two seconds, yet, although the telephotographs received four or five times this proportionate exposure, under-exposure seems to be indicated by the results. The second set referred to is of carvings in red sandstone round the north door of the cathedral at Freiburg in Breisgau—the same fault is here observable; possibly in this case the colour of the stone may have contributed towards under-exposure.

The telephotographer should avoid taking subjects with a strong light behind them; for example, detail on the corner of a building with bright sky for a background. Under such conditions there is pretty certain to be a fogging action over the whole plate, sometimes accompanied by a circular band of increased density on the side of the plate opposite to the highest light, and the image of the object in the negative will be poor and flat. This applies more or less to all subjects in which the view taken by the front or positive lens would include the very brightly lit portion; but the further that high light is from the centre of the field, the less will be the resulting evil. Sometimes the difficulty can be conquered by moving the camera to a point further away from the object until surrounding buildings, owing to the smaller angular elevation at which the camera then points, form a suitable background; if this course is not practicable, choose a time of day when the sun is in front of the building, but obscured by cloud; dark clouds behind the object itself are beneficial.

Telephotographs (and in fact all photographs) of architectural details should be taken in diffused light, in order to obtain good detail throughout the shadows. Strong sunlight is apt to yield photographs that are flat and wanting in gradation, both in shadows and high lights, with excessive contrast (technically termed soot and whitewash). Photographs taken in diffused light are easier to develope, and give the effect of roundness or modelling more truthfully, whilst contrast is easily obtained with a long range of gradations, in place of an abrupt change from white to black.

On no account should direct sunlight shine into the front or positive lens; should the hood on the lens not be deep enough to prevent this, an umbrella or a hat may be used to screen it; as the angle of view of a telephoto lens is small, there is no great danger in so doing.

CHAPTER VII.

PORTRAITURE.

There are two circumstances which prevent me from treating this important branch of the subject as fully as I should wish. In the first place, the size of this book will not allow the inclusion of large illustrations. Telephoto lenses, of a rapid type, are especially useful for taking heads up to or exceeding natural size, direct in the camera. Reducing such to the size of 6 × 4 in order to use them as illustrations would rob these of their special interest. Secondly, I have little or no practical knowledge of this class of work.

Mr. T. R. Dallmeyer in his book ("Telephotography," pp. 114-119) has given the subject particular attention, and includes five comparative photographs showing the effects obtained by ordinary lenses and a telephoto lens. Dr. P. Rudolph has published a monograph on telephotographic lenses ("Gebrauchsanleitung fur Teleobjective," obtainable in an English translation, "A Monograph on the Nature and Application of Telephotographic Objectives," see pp. 13-18), and therein considers the question of portraiture from a technical point of view. His illustrations are four photographs of the same object—a focimeter consisting

of twelve pasteboard vanes of equal size, mounted spirally at intervals of 9 cm. ($3\frac{1}{2}$in.) upon a rod one metre ($39\frac{3}{8}$in.) long—taken with a telephotographic and a positive lens. Both authorities maintain that the telephotographs show better perspective and greater depth of focus than the ordinary photographs—an opinion with which I certainly agree.

Fig. 40. Iris (Telephotograph).

Telephotographic lenses, beside possessing greater depth of focus, combine therewith an opposing quality, viz., greater diffusion of focus than ordinary lenses ; a reference to figs. 40 and 41 may make this point clear, though, owing to the limitations of half-tone prints and the reduction in size, the difference between the two is not nearly so marked as in the original photographs. In fig. 40, the telephotograph, the veining on the falls of the iris is about equally good in the upper and lower flower. This, however, is not the case in the ordinary photograph, fig. 41 ; the veins in the lower are clearly shown, but there is a distinct falling-off in the definition of those in the upper flower—this is due to insufficient depth of focus. On the other hand, there is

more indication of detail in the background in fig. 41, the absence of which in the telephotograph, fig. 40, is due to increased diffusion of focus for more distant objects. The depth of focus of a lens is of course increased by stopping down, but this necessitates longer exposures, and in portraiture this is not desirable. A lens that will give depth of focus over a sufficient range to include the whole of the subject in sharp focus, and at the same time by diffusion of focus obliterate detail in the background, where, more generally, blurred objects are distracting, is surely a valuable tool for the portrait photographer, and these conditions are more nearly attained by telephoto than by any lenses of ordinary focal length, or possibly even than by positive lenses of the same equivalent focal length.

FIG. 41. IRIS (ORDINARY PHOTOGRAPH).

Diffusion may be described as uncorrected spherical aberration, which softens the image in respect of definition, at the focal plane where the image is best defined, and by lack of contrast in planes that are out of focus (compared with the plane of fine definition in the case of a corrected lens) gives the impression of

"depth of focus," which is, perhaps, better expressed as depth of field.

There is another difference between these two photographs which would not at once be recognised. Although the negatives are taken on the same scale, the length from the lower joint in the stalk to the top of the higher flower being the same in both, the flowers do not look and are not actually the same size. The ordinary photograph exaggerates the size of the bud and upper flower (these being nearer), and thus destroys the unity of effect preserved in the telephotograph.

To return to the subject of this chapter. Though telephotographic portraiture is possible with an ordinary rectilinear for the positive lens, which will work at f/8, any great increase of size is quite out of the question (four magnifications would necessitate exposing with f/32). I have secured fully exposed negatives, out of doors in a bright diffused light, with a telephoto lens of this class, upon rapid plates, and an equivalent aperture of f/24, but the lens did not cover the half-plate satisfactorily to the corners, and the exposures were longer than it is safe to give to most sitters. The positive lens should be as rapid as possible. A portrait lens working at f/3, or the special single lens made by Messrs. Zeiss, which has the same initial intensity, will be found suitable.

The three portraits (figs. 42, 43, 44,) were all taken with the same positive—a portrait lens of about eight inches focal length. Fig. 42 shows the position and surroundings of the sitter. For the background the under side of an oilcloth mat was used; the colour was a

red-brown, and proved decidedly too non-actinic for the purpose; the black background resulting from its use makes under-exposure more noticeable, whereas a lighter background of brown paper would have thrown the outline of the hair into relief. The source of light is a large skylight, rather in front of the sitter, that

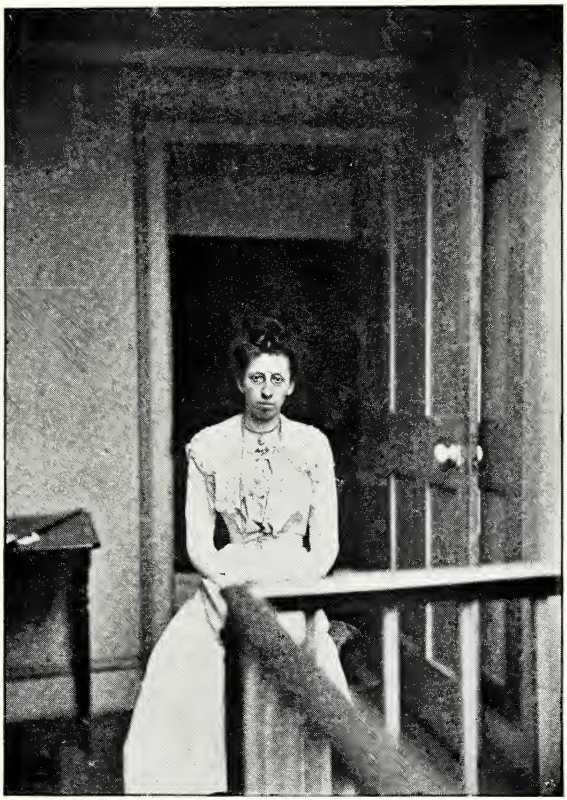

FIG. 42. PORTRAIT TAKEN WITH AN ORDINARY LENS.

lights the stairs, the rails of which are seen in the foreground. The walls all round are painted a light colour, and act as reflectors to prevent heavy shadows,

so that this landing makes a fair studio. The weak point of such a situation is the difficulty of altering the lighting of the sitter to any appreciable extent, and the consequent monotony of the portraits.

Fig. 42 can only be considered in the light of a

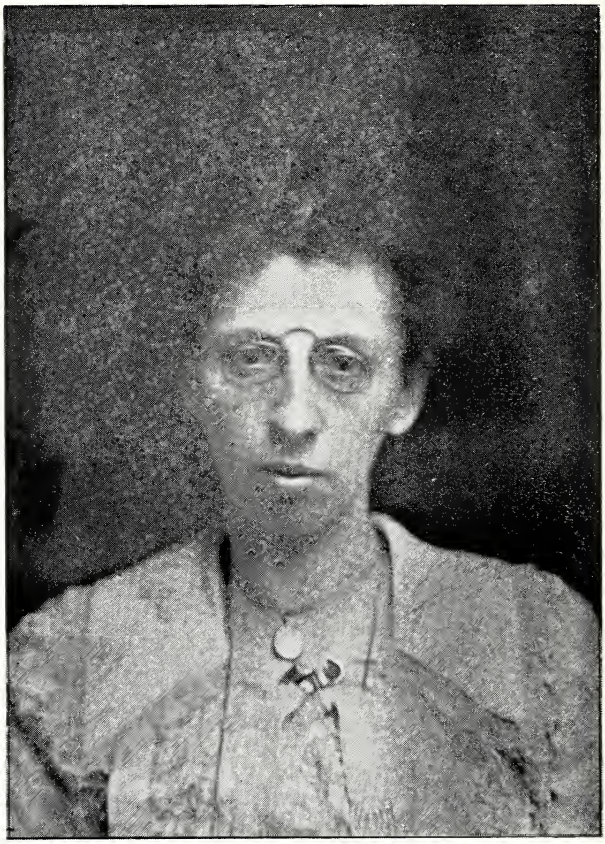

Fig. 43. Portrait taken with a Telephoto Lens from the same Standpoint.

diagram; it was made to show the difference in the size of a head taken with an ordinary lens, compared with a telephotograph taken from the same spot (see

fig. 43). The head is far too small because the focal length of the lens was too short, or the lens was too far away from the sitter. The two remedies indicated do not give identical results by any means, as any movement of the lens and camera at once alters the

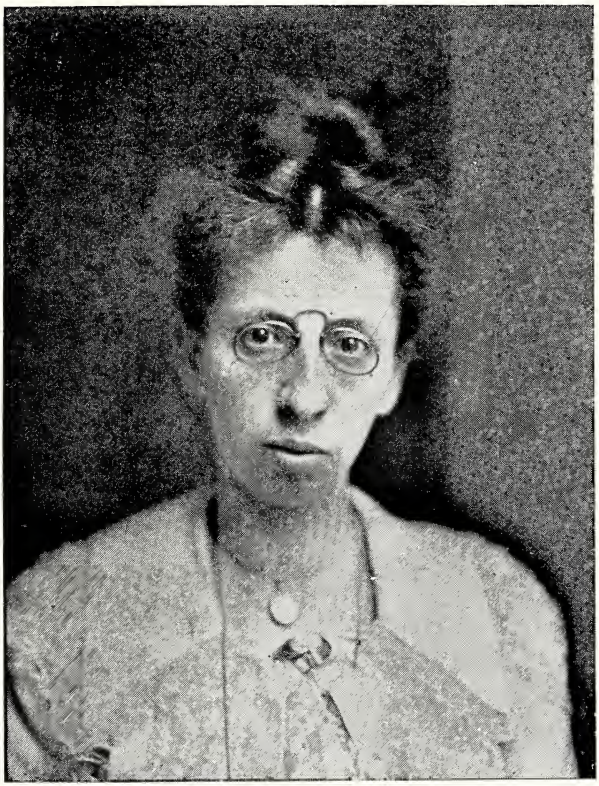

Fig. 44. Portrait taken with an Ordinary Lens, near Standpoint

perspective of the view on the screen. This may be seen by comparing figs. 43 and 44.

Fig. 43, the telephotograph, taken with an equivalent focal length of 32in., is practically the same as an enlargement of fig. 42 by four diameters (or magnifications).

There is no difference between the two other than size. (Theoretically, there is a slight alteration in perspective, but for practical purposes it may safely be neglected.) This print, owing to the long exposure (twenty-two seconds) and consequent slight movements on the part of the sitter, is not as sharply defined as it should be; under less unsatisfactory conditions of lighting there is no reason why the telephotograph should not be as sharp as an ordinary photograph. The question has, however, been already dealt with above.

Fig. 44 shows the effect of increase in size obtained by using the same ordinary lens from a near point of view. If measurements are made down the centre of the face in figs. 43 and 44, they will be found equal; but similarly the width from ear to ear will be found to differ. Now the original negatives were made on exactly the same scale, viz., 3/10 natural size, by focussing a measure which the sitter held close in front of her face, ten inches of the rule being reproduced in three inches on the screen. What then is the explanation of the discrepancy between the measurements we have just pointed out? The nearer point of view which had to be adopted with the shorter focus (ordinary) lens has resulted in enlargement of the nearer features, whilst the outline of the head is not increased to the same extent. This fault is generally referred to as exaggerated perspective, due to the use of a lens of too short focal length; really, the error is due to the position of the lens, not to its focal length.

In this comparison, as the scale of the images is precisely the same (or in any similar case where scale is

taken into account), it is true that an ordinary lens will tend, by exaggerating the size of the near features, to give an effect of increased roundness or relief, whilst a telephotographic lens (or any other lens of great focal length) maintains a truer proportion between the different parts of the face, and consequently gives a flatter appearance to the portrait. For evidence in support of this statement the reader may also turn to figs. 31 and 32.

It has been noticed already in comparing figs. 42 and 43 that the head of the sitter, except in the matter of size, is alike in both. If fig. 42 were suitably enlarged the head would fit fig. 43; the perspective of the two is identical, because both photographs were taken from the same place. The especial advantage of the telephotographic lens is that the size of the image can be altered at will, limited only by the possible extension of the camera, without alteration of the perspective. Owing to the reduced apertures and consequent long exposures, very high magnifications are not practicable. A reference to the table on page 105, assuming that the smallest suitable aperture is known, will give the limit of possible magnifications. If it is not desirable to reduce the aperture beyond f/16, the telephoto lens (having a positive lens working at f/3·16) must not be employed at more than five magnifications. With this limitation the range of useful magnification lies between two and a half and five times, and the possible equivalent focal lengths, with an 8in. positive, from 20in. to 40in.

When the object is very close to the telephoto lens (as

with life size portraiture) the equivalent aperture of the combination is larger than the calculation based on the camera extension and focal length of the negative lens leads one to suppose. To find the correct aperture, focus a distant object upon the screen by use of the rack on the camera, without altering the telephoto lens, and measure the distance as usual from the negative lens to the screen, then, by referring to that column in the table (pp. 105-9), which is calculated for the focus of the negative lens in use, the correct magnification and aperture can be read off. In making an exposure, allowance must be made under these circumstances for the increased camera extension, in the same way that is necessary with an ordinary lens. Take for an example the case of a telephotographic lens with which the distance from the negative lens to the plate is 12in., when focussed on any distant object. A near object is next focussed on the screen by racking out the camera, and the image is in sharp focus when the screen is 48in. from the negative lens. The camera extension is now set at four times the normal focal length of the lens, and the exposure must be multiplied by sixteen. Precisely the same increase of exposure would be required if a 12in. ordinary lens were employed at 48in. extension from the centre of the lens to the plate. For more exhaustive treatment of the problems involved the reader should consult the treatises quoted earlier in this chapter.

CHAPTER VIII.

THE TELEPHOTOGRAPHY OF ANIMALS.

Most photographers are acquainted with the admirable studies of wild birds taken by Mr. R. B. Lodge with the telephoto lens. Such work demands a large amount of patience and careful stalking, or lying in wait long before the actual exposure is made. By the ordinary photographer perhaps, and certainly by the well informed "man in the street," a telephoto lens is regarded as possessing powers little short of miraculous. It will take photographs of objects at great distances; there is consequently no need to get to close quarters with the bird to be photographed, and all fear of frightening it is at an end. A little thought, or, better still, a trial or two, will soon convince anyone that wild birds are not easy even to telephotograph. A rapid lens is necessary; if a portrait lens working at f 3·16 is used and five magnifications are obtained, the combination will then be working at an equivalent aperture of f/15·8, practically f/16. Under these conditions the telephoto lens, at five times the distance, will give as large an image of the bird or animal as the front (or ordinary) lens, or if the position of the camera is the same in each case the telephoto will represent the object five times the size that it appears in the ordinary photograph. (This statement is not strictly true for near

objects, but is then a rough approximation.) The size of a bird such as a sparrow in an ordinary photograph is so minute that multiplying it by five still leaves it insignificant, whilst to obtain this gain in size compels the use of a lens working at f/16, as has been already mentioned. Small birds and animals are very quick in their movements, and there is a consequent need for

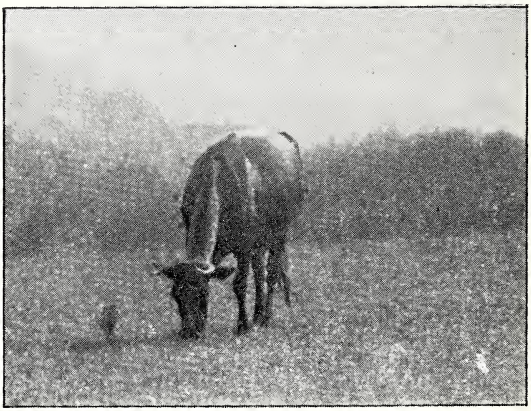

Fig. 45 Cow and Chicken.

short exposures. The constant problem in this work is how to reconcile the desire for high magnification with the necessity of short exposure. Another feature in the case is the protective colouring of the birds themselves, which renders their effective photographic treatment difficult, and the surroundings are generally of a non-actinic colour.

Domestic birds and animals do not present such serious difficulties—they are always to be found, they do not hide themselves under heavy foliage, and it is generally possible to choose a time of day when the light

is good. But even with these, patience, or an entire absence of hurry, is wanted, and a thoughtful assistant is a very great help. Many photographers have turned their attention to wild birds, but the commoner domestic birds and animals have hardly received the attention they merit. Excepting in the early stages of enthusiasm, when the young amateur has wearied his relations with portraiture and turned his attention to the family dog or cat, few photographers consider animals unless as accessories in landscape work, to give "living interest" to the view.

A complicated camera is not required, there is no need for a swing back or a rising front, but to secure the best results a rapid type of positive lens is a *sine quâ non*, also some form of shutter. For the larger animals an ordinary roller blind shutter working in front of the lens is satisfactory, and enables the photographer to give exposures that are short enough for most subjects. The worker must not be led astray by the idea that the shorter the exposure given the better will be the result, or that very short exposures are necessary; one-fifteenth of a second is generally not too long for standing objects, though movement is naturally more noticeable when animals are photographed on a large scale, and must be guarded against.

If the negatives are intended solely for making lantern slides by contact an ordinary lens is perfectly suitable. There is no need to work with a telephotographic lens; the latter, of course, will give larger images, so large in fact as to appear ridiculous when thrown on the lantern screen, because the animals are

magnified so much beyond their usual size. A contact slide of the cow's head (fig. 46), on account of the enormous size of the thing on the screen, is laughable. When prints for purposes of illustration are the end, this objection is removed, the animal will not be shown

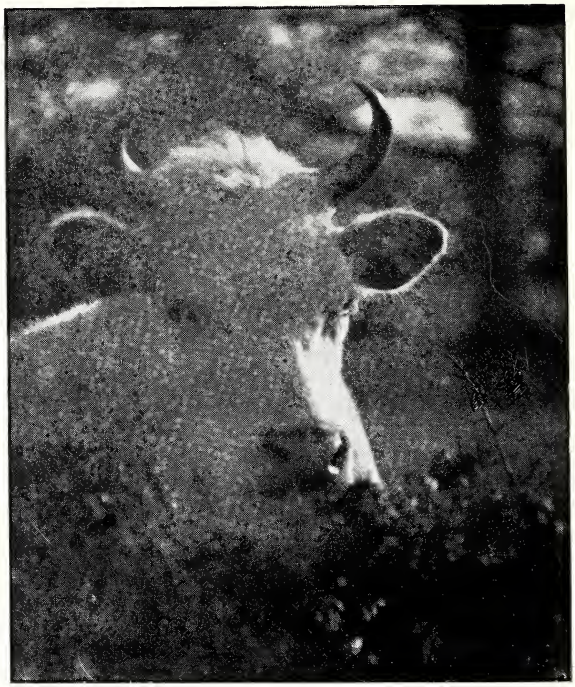

FIG. 46. "LOOKING O'ER THE HEDGE."

life-size even, and then a telephotographic lens is of great use—the animal (or animal's head), can be photographed as large as possible, or a restive beast taken at a greater distance. With an ordinary lens (setting aside subsequent enlargements from the negative) the only way of getting the animal larger in the photograph

is to go closer with the camera—a plan which increases the size until all the surroundings are dwarfed and the proportions of the different parts of its body are out of truth. The telephotographer can, within certain limits, choose the distance from his quarry that gives the most satisfactory perspective, and alter the size of the image to suit his plate, by varying the camera extension.

The question of perspective is too frequently overlooked; in fact, photographers have become so accustomed to hand-camera work taken with short focus lenses, that they are often too tolerant. The photograph of a donkey (fig. 47) was taken with a 6in. lens (f/5·6, exposure $\frac{1}{4}$ second), a lens of rather longer focus than is used with most hand cameras upon the quarter-plate. No attempt was made to secure an exaggerated result, or a more telling example could easily have been produced. For the present comparison, this print is neither better nor worse than most hand-camera shots of similar subjects, yet there is an evident lack of truth in the size of the head and forelegs, and the rendering of the hind quarters. This defect can be avoided by placing the camera screen parallel to the animal, but such photographs, though they have their uses, soon pall. The other and better way is to photograph the animal from a greater distance, and counteract the diminished size of the image by using a telephoto or other lens of long focus. The two studies of cows (figs. 48 and 49) were made in this manner by means of a telephoto lens, working at an equivalent focus of 24in. (rapid telephoto lens by Messrs. Voigtländer and Sohn, positive

Fig. 47. Donkey (Ordinary Photograph).

lens at f/3, equivalent aperture f/9·5, exposure $\frac{1}{25}$ second). Both photographs are free from the fault pointed out in the last mentioned example.

Many animals are sufficiently staid to be taken without any finder. There is, of course, the risk that the donkey will put his ears beyond the edge of the plate, or that the cow will march out of the field of sharp definition, but care and correct anticipation of their movements will reduce the crop of failures; besides, a lenient view is now more general with regard to photographs with diffused focus. The Alderney on page 85 suffers from this defect; she walked some little distance, between the times of focussing and exposure, and away off the plane of sharp focus.

It is quite another thing to take photographs of moving animals. I have tried three methods. The first and simplest is to wait with the camera, the lens focussed upon a point that the animal must pass, the shutter set and the plate ready for exposure; at the

Fig 48. Alderney Cows (Telephotograph).

right moment the shutter is released and the exposure made. In this way animals can be successfully included in landscape subjects, but it is unsafe to adopt such a course for the larger treatment of an animal alone, owing to the lack of depth of focus when objects are near to the lens.

The twin lens method at first sight seems very likely to be useful. The lenses need not be of the same pattern, nor is it essential that the camera extension be

absolutely the same for the finder and the lens used to make the exposure. A rough camera was fitted over the bellows of the one in use, the screen of the finder being fixed to the focussing back of the camera. Both lenses were accurately focussed on their separate screens as a first step, at about the camera extension required, and upon the same object at a suitable distance. Any subsequent focussing was performed with the rack on the camera only, and it was found safe to rely on the finder for sharp focussing within reasonable limits. A few exposures on near objects sufficed, however, to convince me that the idea was impracticable. The head of an animal might appear on the finder below the centre of the screen, whilst nothing but its legs were photographed by the lower lens. It is necessary, of course, to make some allowance for the difference between the two images brought about by the separation of the lenses, but for near objects the field of view is so different, and varies so greatly with varying distances, that it is never safe to trust to the finder. Of course, for distant objects the views on the two screens are almost identical, but with such work there is little, if any, need for a finder. The weight of the apparatus, including as it does two telephoto lenses and a double camera, is a drawback, increased further by its cumbrous size and shape. The cost of the necessary lenses would deter many photographers from working this method, were it open to no other objections.

For small plates, at any rate, the lens that takes the photograph should itself give the image on the finder. Among the makers who supply cameras designed to

this end I may mention Messrs. J. H. Dallmeyer, Ltd. (the "Naturalist's" hand camera), and Messrs. Shew and Co. (the "Reflector" camera). By means of a mirror or mirrors, the image formed by the photographing lens is seen and focussed on the finder screen up to the time of exposure; the exposure is made by releasing the mirror, which is drawn by springs out of the field of the lens, and the mirror in its turn actuates a focal plane shutter. The illustrations on pages 41 and 44 were taken with a "Naturalist's" hand camera, but in all cases the camera was supported by a stand.

In designing a camera of this type I should prefer a finder that gives the whole of the picture. The

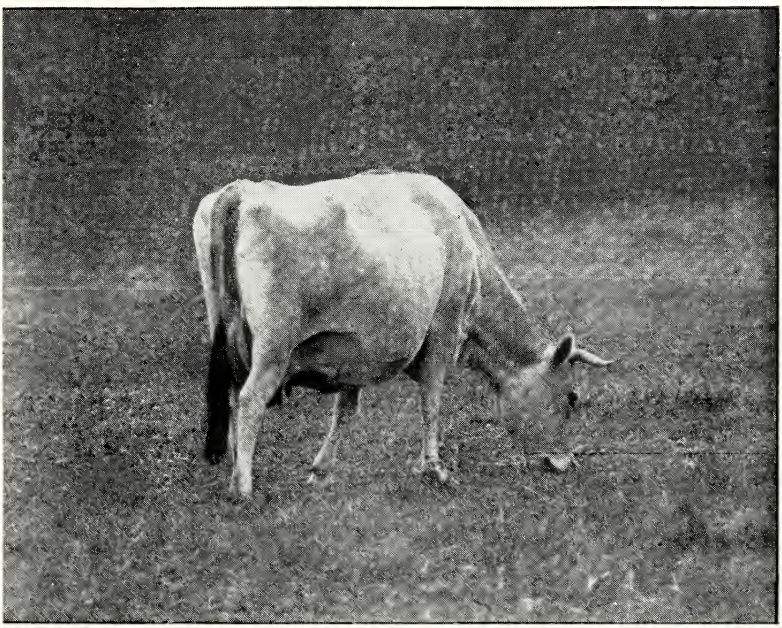

Fig. 49. Alderney Cow (Telephotograph).

positive lens should be as large as possible, and be capable of working alone at an aperture of about f/3. The advantage attaching to the use of a positive lens of greater focal length has been already explained; larger images are obtained with the same equivalent aperture than with lenses of less focal length. It is not necessary to have any rackwork on the camera itself, as all focussing can be performed by adjusting the telephoto lens, and as absence of movement in the parts of the camera tends to greater rigidity it may even be undesirable. Sufficient latitude in the size of the image for snap-shot exposures can be obtained by so constructing the camera that the lens may be placed in two positions—when near to the plate working at three, and in the further position at four or five, magnifications. The magnification and resulting equivalent focal length might also be varied by the use of negative lenses of different focal lengths.

CHAPTER IX.

EXPOSURE AND DEVELOPMENT.

The speed or rapidity of a telephoto lens varies inversely with the extension of the camera used, or, in other words, the distance from the back of the negative lens to the screen. It is, therefore, not quite as easy to guess the proper exposure as when an ordinary lens is used; still, a simple calculation is all that is required. The f value of the lens is obtained by multiplying the f number of the stop in the front lens by the magnification. The first step then is to find the magnification; this may be done experimentally, though it is rather a cumbrous method, in the following manner. The front lens alone is focussed on the object to be taken, and the image upon the screen is measured. Let us suppose that it is an inch long. Next take out the front lens and screw it into place upon the telephoto attachment, and, putting this into position in the camera front, rack out the camera. The object is then brought sharply into focus by means of the rack and pinion on the telephoto lens. Measurement of the image shows that it is now perhaps 3in. long. We assumed that the image given by the front lens was 1in., and by using a negative lens the size has been increased to 3in.; we have therefore

obtained three magnifications. There are some who recommend this method on the score of simplicity and ease, but in practice unscrewing and screwing the lenses and shifting the focussing screen waste time and labour.

To find the magnification by measuring screen images involves two measurements, and a possibly intricate calculation. The alternative plan demands only one measurement, that of the camera extension, and but little figuring, or if a table (such as that given later, pp. 105-115) has been previously drawn up, a reference thereto will show the magnification without any arithmetic. It is not easy to measure accurately small images on the ground-glass. The image given by the positive lens alone is of necessity small, and, on the other hand, the absence of bright illumination in the other image, owing to the smaller aperture of the telephoto lens, introduces a further difficulty in the comparison.

It is practicable to find the equivalent focal length direct, and from this to derive the magnification upon which the exposure is based. The method (for which I am indebted to Mr. Ferguson) is as follows: Measure any large conspicuous part of the telephoto image on the camera screen, marking the length on the edge of a piece of paper. Then place the paper edge upwards on the front of the camera, and keeping one eye on the paper in line with the object chosen, retire behind the camera until the marked paper corresponds in length with the object; the distance from the eye to the piece of paper is equal to the equivalent focal length of the lens under these conditions. To find the magnification divide the

equivalent focal length by the focal length of the positive lens. For example, the distance from the eye to the paper is 40in., *i.e.*, the equivalent focal length is 40in. If an 8in. positive lens is used, then the magnification $= \frac{40}{8} = 5$.

The simplest method, in my opinion, is to calculate the magnification; this can be readily done, if the focal length of the negative lens and the distance from the negative lens to the screen are known, by applying the rule quoted below. The focal length of the negative lens is (or ought to be) marked upon the mount, and, if not, can be found by enquiry of the manufacturers; the photographer must measure the distance from the negative lens to the centre of the screen.

Rule.—To find the magnification, divide the distance from the negative or back lens to the focussing screen by the focal length of the negative lens and add 1 to the result.

Example.—A negative lens of 4in. focal length is used, and the distance from the lens to the screen is 8in. Then 8 divided by 4 equals 2, add 1, the total is 3; the magnification in such case is 3.

$$\text{Magnification} = \frac{8}{4} + 1 = 3.$$

The intensity or f value of the telephoto lens is easily found by applying the following rule:

Rule.—To find the intensity of a telephoto lens, multiply the f number of the stop in the front, or positive lens, by the magnification.

Example.—A positive lens, stopped down to f/11·3

with a negative attachment, may give three magnifications, then the f number of the complete telephoto lens under such circumstances is f/33·9, or practically f/34. When the equivalent aperture of the telephoto lens is known, it is easy to find out what the proportionate exposure should be by using a table of U.S. numbers.

It will be seen that increased magnification or gain in size of the image is accompanied with the drawback of longer requisite exposure. What is the proportionate exposure? Let us revert to the example previously quoted, and consider the effect of the use of the negative lens upon the brightness of the image cast upon the screen and sensitive plate. Let the front or positive lens yield an image of an object (say a square piece of white paper) of the size of 1in. square, a 4in. negative lens is added, and the camera extended until the distance from the negative lens to the screen is 8in., when, as already shown, a magnification of 3 is obtained; the image will now occupy a 3in. square (it should be remembered that the magnification is linear), and the area is 9 square inches. The amount of light passing through the front lens from the square piece of white paper is a fixed quantity, but the negative lens spreads the light, which otherwise would fall upon 1 square inch of the sensitive surface, over 9 square inches, and if the density of the two resulting photographs is to be the same (with similar development), then this telephotograph should receive nine times the exposure given to the photograph taken with the front lens alone. That is to say, to make up for the lower actinic power of the light the exposure must be proportionately increased.

The exposure required for a telephotograph can be found in several ways. If the requisite exposure for a certain subject, with the front or positive lens and a particular stop, is known, then the time given for a telephotograph should be increased directly with the square of the magnification. Supposing 1 second is the correct exposure for a given subject with the positive lens at f/11·3, then if without moving the position of the camera a negative lens is added and three magnifications obtained, and the front lens is still set at f/11·3, the correct exposure would be 9 seconds (1 second multiplied by the square of 3), or for five magnifications, 25 seconds (1 second multiplied by the square of 5.)

This method is accurate and practicable, but without an extended table of squares it is tiresome in application for magnifications expressed partially by a fraction. To do away with the troublesome calculations involved in the squaring of fractions, I have prepared a table of squares from $2\frac{1}{2}$ to 20, ascending by $\frac{1}{8}$ at each step, and include this with the necessary camera extensions at the end of this book.

So far, relative exposure alone has been considered; for determining the actual exposure some form of sensitometer is desirable. Any form that tests the actinic power of the light is suitable; for example, the Stanley sensitometer, or Watkins exposure meter, in both of which the time that a piece of bromide paper takes to print out to a standard tint is the basis of subsequent calculations. I use the Stanley sensitometer (it is smaller, cheaper, and simpler than most), and for this instrument, allow different percentages of the time

reading, according to the subject which is being photographed. For architectural detail 25 per cent. of the time that the sensitive paper takes to darken will be correct for a lens working at f/16 upon an ordinary plate. Large portraits may require 33 to 50 per cent., and distant landscapes 15 per cent. or less. Strong contrast or proximity of the subject should lead to increased exposure. (See explanation of tables, second method.)

In determining the exposure for near objects such as architectural detail or portraits, consider the part that is to be included in the telephotograph, not the more general view which the ordinary lens would take from the same spot. A general view of a doorway such as shown in fig. 33 would require 12½ to 15 per cent. of the time reading of the Stanley sensitometer with an 8in. lens at f/16 covering the half-plate, but for a photograph of the capital shown in fig. 31, 25 to 30 per cent. would not be too much, and upon the latter estimate the exposure should be based. For interior work such as the three examples, figs. 37, 38, 39, the exposure required for a general view and a telephotograph of detail may be the same with the same aperture, generally 25 to 30 per cent. of the sensitometer reading for f/16. When this is the case, if the stop in the positive lens is not altered the exposure of a telephotograph, as compared with the ordinary general view, varies directly with the square of the magnification. The reverse may hold good when landscapes are dealt with, as the telephotograph may omit heavy foreground foliage which in the ordinary photograph prolongs the necessary exposure.

I do not think that any exposure meter of the slide rule pattern is of much use for architectural photography. In this work the correct exposure often varies enormously according to the position of the object. The most sensible plan to adopt is that of testing the actinic value of the light falling upon the most important part of the object. The paper in the sensitometer should be exposed towards the camera, and the photographer should aim at getting the value of the light at the medium point—that is to say, the sensitometer should neither be exposed in the strongest light nor the deepest shadow. The sensitometer, if it cannot be held against the subject, must be placed in a similar position as to lighting.

Those who are accustomed to the use of a Watkins exposure meter will find little difficulty in applying the instrument to telephotography, as its purpose is to give the correct exposure for standard stops. The application of those meters which work out the exposure required for an ordinary standard aperture is dealt with later. (See explanation of tables under first method.)

For almost all purposes the plate ordinarily used by the photographer will be suitable for telephotography; special remarks on this head are, therefore, hardly called for. For distant landscapes particularly, orthochromatic plates should be used, and also for telephotographs of wild birds, on account of the predominating green of the surroundings. Snap shot exposures are best made upon the fastest plates obtainable, whilst for architecture a slow plate is undoubtedly the most suitable. All plates should be backed, though this precaution has no special bearing upon telephotography.

The development of telephotographic negatives also follows the ordinary lines. The larger images may at first be deceptive, because, with the same actual contrast as negatives taken with ordinary lenses, telephotographic negatives appear rather thinner to the eye. In an ordinary negative the high light and shadow are near together, and the contrast appears sharp, but in a telephotographic negative with, say, five magnifications, the distance between them is five times as great, and the gradation being more gentle, the image visually has less contrast. It will be found more difficult to obtain contrast in telephotographs of distant landscapes, and for such work it may be well to modify the developer.

The particular developer to use is very largely a matter of custom. For architectural telephotography a non-staining form of the pyro soda developer is to be preferred, and it is more convenient to have the pyro solution in a concentrated form. The following formulæ answer admirably:

No. 1.

Pyrogallic acid	1 ounce	or	100 grammes.
Sodium sulphite	3 ,,	,,	300 ,,
Citric acid	¼ ,,	,,	25 ,,
Water to make	10 ,,	,,	1,000 cc.

Dissolve the sodium sulphite and citric acid in eight or nine ounces (800 or 900 cc.) of water and pour the solution into the bottle containing the pyro, then make the bulk up to ten ounces (1000 cc.) by adding water as required. The water should be boiled, and time is saved by dissolving the sodium sulphite and citric acid in hot water. The same remarks apply to making up the soda solution No. 2.

No. 2.

Washing soda	2	ounces or	100 grammes.
Sodium sulphite ...	2½	,, ,,	125 ,,
Water to make	20	,, ,,	1,000 cc.

No. 3.

Potassium bromide ...	1	ounce or	100 grammes.
Water to make	10	,, ,,	1,000 ,,
For use take No. 1	30	minims or	6·25 cc.
No. 2	½	ounce ,,	50 cc.
No. 3	10	minims ,,	2·98 cc.
Water to make	1	ounce ,,	100 cc.

For instantaneous telephotographs a developer which gives a green or brown stain is better than the one above mentioned. I do not know a better developer for this class of work than the "Imperial Standard" developer of the Imperial Dry Plate Co. The only liberty I take with the stock solutions is to omit the potassium bromide from the reducer, the No. 1 solution.

No. 1.

Pyrogallic acid	55	grains or	6 grammes.
Metol	45	,, ,,	5 ,,
Potassium metabisulphite	120	,, ,,	14 ,,
Water (boiled or distilled) to	20	ounces	1,000 cc.

No. 2.

Washing soda	4	ounces	200 grammes.
Water (boiled or distilled) to	20	,,	1,000 cc.

No. 3.

Potassium bromide ...	1	ounce or	50 grammes.
Water to	10	,, ,,	500 ,,

Take half an ounce (or 50 cc.) No. 1, half an ounce (or 50 cc.) No. 2, ten minims (or 2 cc.) No. 3. For very short exposures the quantity of the reducer, No. 1, may advantageously be diminished by half, and the bulk

made up with water. In extreme cases the developer should be mixed as follows: Thirty minims (or 6 cc.) No. 1, half an ounce (or 50 cc.) No. 2, with bromide omitted; the bromide may be added to the developer subsequently, after detail is obtained, if this is thought necessary, to secure greater density.

If the use of metol is objected to, a good developer giving a stained image can be made up with pyro as follows:

No. 1.

Pyrogallic acid	1 ounce	or	100 grammes.
Potassium metabisulphite	50 grains	,,	10 ,,
Water (boiled or distilled) to	10 ounces	,,	1,000 cc.

No. 2.

Washing soda	4 ounces	or	200 grammes.
Water (boiled or distilled) to	20 ,,	,,	1,000 cc.

For the developer take thirty minims (or 6 cc.) of No. 1, half an ounce (or 50 cc.) No. 2, water to one ounce (or 100 cc.), and bromide if desirable. This developer may also be varied in the manner suggested for the pyro metol formula by reducing the quantity of pyro, or adding a restrainer.

CHAPTER X.

EXPLANATION OF THE TABLES.

For practical purposes greater accuracy than a measurement to an eighth of an inch in the distance from the negative lens to the screen is not necessary, and without expensive scales and fittings to the camera it is not possible to find smaller differences. Wherever the measure is exact to the eighth of an inch it is so given in the table, in preference to the use of decimals.

Decimals may be converted into vulgar fractions by referring to the foot of each page, and in doing this it is better to choose the smaller in preference to the larger nearest $\frac{1}{8}$.

Example.—The measure 6·975in. is rather less than 7in., but the camera should preferably be set at $6\frac{7}{8}$in. extension (unless a nearly exact magnification of $4\frac{7}{8}$ is required with a negative lens of 1·8in. focus).

If the distance between the negative lens and the screen is intermediate between two of the figures given in the table, the calculation of the exposure should be based upon the larger of the two figures.

Example.—A negative lens of 3in. focus is working at an extension of 14in.; consider this as $14\frac{1}{4}$in. and the magnification as $5\frac{3}{4}$ (not $13\frac{7}{8}$in. and magnification $5\frac{5}{8}$.) The difference between 31·64 times and 33·06

times (square of magnification) the exposure required by the ordinary lens is not great, and any little overplus will make up for part of the light lost in passing through the negative lens, which factor has not been taken into account in drawing up the tables.

The proportionate exposures for various f apertures are given in the column headed U.S. Number. It is assumed that the exposure required with an aperture of f/4 is 1. To find the equivalent exposure for any other stop, multiply the exposure required for f/4 by the U.S. Number (uniform system number) of the stop in question.

There are two methods of arriving at the exposure for a telephotograph. First method—

Find the exposure required for the ordinary lens, with the same stop that is to be used in it for the telephotograph, and multiply the time arrived at by the square of the telephotographic magnification.

Take as an example the capital shown in the telephotograph, fig. 31. The conditions were as follow:

Light according to Stanley sensitometer sixteen seconds.

Negative lens, 75 mm. (or 3in.)

Positive lens, 179 mm. (or 7in.)

Distance from negative lens to the screen, 35 centimetres (or 14in.)

Referring to Tables II. or III., English or French measure, and taking the larger nearest measurement (see above) 35·62 cm. (or $14\frac{1}{4}$in.), the magnification will be found to be $5\frac{3}{4}$, the square of which is given as 33·06.

Assuming that the correct exposure for the capital taken with the positive lens alone is five seconds for f/16 (30 per cent. of the light) then the correct exposure for the telephotograph will be 33·06 × 5 seconds = 2 minutes 45 seconds.

Second method—

Give an exposure proportionate to the equivalent aperture of the telephoto lens.

The conditions remaining as in the last example, the equivalent aperture of the lens with f/8 stop is found to be f/46, and the proportionate exposure 132·25.

The U.S. number for f/16 = 16. Hence, compared with f/16, the exposure should be multiplied by the following fraction: $\frac{132{\cdot}25}{16.}$

The exposure for f/16 = 30 per cent. of 16 seconds $= \frac{30 \times 16}{100}$ Multiplying this by $\frac{132{\cdot}25}{16}$ gives the following fraction: $\frac{396{\cdot}75}{10} = 39{\cdot}675$ seconds.

The correct exposure, then, for the telephoto lens working with an aperture of f/8 in the positive lens is 39·675 seconds, say 80 seconds f/11, and for f/16 160 seconds = 2 minutes 40 seconds.

This method is the better for sensitometers which only test the strength of the light, but for use with others which work out exposures for a particular stop the first plan is the simpler.

Both methods are equally accurate; the slight difference of five seconds between the two results is explained by the fact that five was taken as thirty per cent. of sixteen in the former calculation, and the true value 4·8 seconds in the latter.

It may be noted that the tables do not take into consideration the focal length of the positive lens, as this has no bearing upon the magnification and exposure, but determines the equivalent focus. (See p. 9).

Distance from the Negative Lens to the Screen.—This should in theory be measured from the exposed back surface of the negative lens to the screen. It is well to avoid danger of scratching the glass by measuring to the metal setting, or if the projection of the negative lens inside the camera is always the same (as for example with mounts of the types illustrated in figs. 7, 8, 9), the point to which the negative lens reaches may be conveniently marked on the base of the camera, when all measurements can be made outside the bellows, which is undoubtedly the better plan.

TABLE I.

As a means of comparing the rapidity of ordinary with telephotographic lenses, I have calculated the proportionate exposures for the f apertures 1 to 19, also for such intervening apertures as are in common use. These are given below. Taking an exposure of 1 with the stop f/4 as the basis, the figures in the columns headed U.S. Number (uniform system number) give the greater or lesser exposures required by other apertures. For smaller apertures the reader is referred to table II., where, under the heading, Aperture of Lens f/8, the proportionate exposures (U.S. number) for f/20 to f/160 will be found.

Aperture.	U.S. No.	Aperture.	U.S. No.	Aperture.	U.S. No.	Aperture.	U.S. No.
f/1	·0625	f/4·472	1·25	f/7 5	3·515	f/12 648	10
f/1·8	·2025	f/4·5	1·265	f/7·745	3·75	f/13	10·56
f/2	·25	f/5	1 562	f/8	4	f/14	12·25
f/2.236	·3125	f/5·477	1·875	f/8·660	4 687	f/14·142	12·5
f/2·3	·3306	f 5·656	2	f/8·942	5	f/15	14·062
f/2·738	·468	f/6	2 25	f/9	5·062	f/15·81	15·625
f/3	·562	f/6·324	2·5	f/10	6·25	f/16	16
f/3·162	·625	f/6·5	2·640	f/11	7·562	f/17	18.062
f/3·6	·81	f/6·8	2·89	f/11·313	8	f/17·32	18·75
f/3·872	·937	f/7	3·062	f/12	9	f/17·888	20
f/4	1	f/7·071	3·125	f/12 247	9 375	f/18	20·25
f/4·2	1·102	f/7·211	3·25	f/12·5	9·765	f/19	22·56

TABLE II.

English Measure.

Magnifications and rapidity of telephotographic lenses at various extensions of the camera.

Setting forth the requisite distance from the negative lens to the screen, and the resulting rapidity of the telephoto lens, for magnifications of two and a half to twenty times inclusive, ascending by magnifications of one-eighth.

Suitable for all positive lenses having an equivalent aperture of f/3·16 or f/8, or in conjunction with Table IV. for those possessing an equivalent aperture of f/9.

This table is designed for use with the following negative lenses, or others of similar focal length

Messrs. R. & J. Beck, Ltd.
No. 1 focus 1·9 inches.
" 2 " 2·8 "
" 2A " 3·3 "
" 3 " 3·8 "

Messrs. J. H. Dallmeyer, Ltd.
Focus 1·8 inches.
" 2·4 "
" 3 "
" 4 "
" 5 "
" 6 "

Messrs. Ross, Ltd.
(See Messrs. Carl Zeiss.)

Messrs. C. A. Steinheil Söhne.
Nos. 1 & 2 focus 48 mm. = 1·9 inches.
" 3 & 4 " 67·5 mm. = 2·8 " (nearly).
" 5 " 75 mm. = 3 "

Messrs. Carl Zeiss.
No. 1 focus 1 inch.
" 2 " 1·75 "
" 3 " 2·25 "
" 4 " 3 "
" 5 " 4 "
" 6 " 5 "

DISTANCE FROM NEGATIVE LENS TO SCREEN IN INCHES.

Square of Magnification.	Magnification.	6in. Neg. Lens.	5in. Neg. Lens.	4in. Neg. Lens.	3.8in. Neg. Lens.	3in. Neg. Lens.	2.8in. Neg. Lens.	2.4in. Neg. Lens.	2.25in. Neg. Lens.	2in. Neg. Lens.	1.9in. Neg. Lens.	1.75in. Neg. Lens.	1.6in. Neg. Lens.	Magnification.	Positive Lens at f/3·16.	U.S. Number.	Positive Lens at f/8.	U.S. Number.
6·25	2½	9	7½	6	5·7	4½	4·2	3·6	3⅜	3	2·85	2⅝	1½	2½	f/7·9	3·90	f/20	25
6·89	2⅝	9¾	8¼	6½	6·175	4⅝	4·55	3·9	3⅝	3¼	3·087	2·843	1⅝	2⅝	f/8·29	4·30	f/21	2·7·56
7·56	2¾	10½	8¾	7	6·65	5	4·9	4·2	3·937	3½	3·325	3·062	1¾	2¾	f/8·69	4·72	f/22	30·25
8·26	2⅞	11¼	9⅜	7½	7·6	5⅜	5¼	4½	4·218	3¾	3·562	3·281	1⅞	2⅞	f/9·08	5·15	f/23	33·06
9	3	12	10	8	8·6	6	5·6	4·8	4½	4	3·8	3½	2	3	f/9·48	5·66	f/24	36
9·76	3⅛	12¾	10⅝	8½	8·075	6⅜	5·95	5·1	4·781	4¼	4·037	3·825	2⅛	3⅛	f/9·87	5·98	f/25	39·06
10·56	3¼	13¼	11¼	9	8·55	6¾	6·3	5·4	5·062	4½	4·275	4·05	2¼	3¼	f/10·27	6·59	f/26	42·25
11·39	3⅜	14¼	11⅞	9½	9·025	7⅛	6·65	5·7	5·343	4¾	4·512	4·275	2⅜	3⅜	f/10·66	7·10	f/27	45·56
12·25	3½	15	12½	10	9·975	7½	7	6	5·9	5	4·987	4·725	2½	3½	f/11·06	7·64	f/28	49
13·14	3⅝	15¾	13⅛	10½	9·975	7⅞	7·35	6·3	5·906	5¼	4·987	4·725	2⅝	3⅝	f/11·45	8·2	f/29	52·56
14·06	3¾	16½	13¾	11	10·45	8¼	7·7	6·6	6·187	5½	5·225	4·95	2¾	3¾	f/11·85	8·7	f/30	56·25
15·01	3⅞	17¼	14⅜	11½	10·925	8⅝	8·05	6·9	6·468	5¾	5·462	5·175	2⅞	3⅞	f/12·24	9·4	f/31	60·06
16	4	18	15	12	11·4	9	8·4	7·2	6·3	6	5·7	5·4	3	4	f/12·64	9·9	f/32	64
17·01	4⅛	18¾	15⅝	12½	10·312	9⅜	8⅛	7·8	7·031	6¼	5·937	5⅝	3⅛	4⅛	f/13·03	10·6	f/33	68·06
18·06	4¼	19¼	16·1	12¾	10·725	9¾	8·4	8·1	7·312	6½	6·175	5·85	3¼	4¼	f/13·43	11·3	f/34	72·25
19·14	4⅜	20¼	16·7	13½	11·137	10⅛	8·82	8·4	7·593	6¾	6·412	6·075	3⅜	4⅜	f/13·82	11·9	f/35	76·56
20·25	4½	21	17·2	14	11·55	10½	9·8	8·4	7·875	7	6·65	6·3	3½	4½	f/14·22	12·6	f/36	81
21·39	4⅝	21⅜	18·4	14⅜	13·775	10⅝	10·15	8·7	8·156	7¼	6·887	6·525	3⅝	4⅝	f/14·61	13·3	f/37	85·56
22·56	4¾	22½	18·2	15	14·4	11¼	10·85	9·3	8·437	7½	7·125	6·75	3¾	4¾	f/15·01	14·1	f/38	90·25
23·76	4⅞	23¾	19·3	15·1	14·725	11⅝	11·2	9·6	8·718	7¾	7·362	7·6	3⅞	4⅞	f/15·40	14·8	f/39	95·06
25	5	24	20	16	15·2	12	11·55	9·9	9·281	8¼	7·837	7·425	3¾	5	f/15·8	15·6	f/40	100
26·26	5⅛	24¾	20⅝	16½	15·675	12⅜	11·55	9·9	9·281	8¼	7·837	7·425	3⅞	5⅛	f/16·19	16·4	f/41	105·06
27·56	5¼	25½	21·4	17·1	16·15	12¾	11·9	10·2	9·562	8½	8·075	7·65	4	5¼	f/16·59	17·2	f/42	110·25
28·89	5⅜	26¼	21·7	17·3	16·625	13⅛	12·4	10·4	9·843	8¾	8·312	7·875	4⅛	5⅜	f/16·98	18	f/43	115·56
30·25	5½	27	22·1	18	17·1	13½	12·6	10·8	10¼	9	8·55	8·1	4¼	5½	f/17·38	18·8	f/44	121
31·64	5⅝	27¾	23·8	18½	17·575	13⅝	12·95	11·1	10·406	9¼	8·787	8·325	4⅜	5⅝	f/17·77	19·8	f/45	126·56
33·06	5¾	28½	23·3	19	18·05	14¼	13·3	11·4	10·687	9½	9·025	8·55	4½	5¾	f/18·17	20·4	f/46	132·25
34·51	5⅞	29¼	24·8	19½	18·525	14⅝	13·65	11·7	10·968	9¾	9·262	8·775	4⅝	5⅞	f/18·56	21·3	f/47	138·06
36	6	30	25	20	19	15	14	12	11¼	10	9·5	9	4¾	6	f/18·96	22·4	f/48	144
37·51	6⅛	30¾	25·8	20½	19·475	15⅜	14·35	12·3	11·531	10¼	9·737	9·225	4⅞	6⅛	f/19·35	23·2	f/49	150·06
39·06	6¼	31½	26·4	21	19·95	15¾	14·7	12·6	11·812	10½	9·97	9·45	5	6¼	f/19·75	24·2	f/50	156·25
40·64	6⅜	32¼	26·7	21½	20·425	16⅛	15·05	12·9	12·093	10¾	10·212	9·675	5⅛	6⅜	f/20·14	25·2	f/51	162·56
42·25	6½	33	27½	22	20·9	16½	15·4	13·2	12⅜	11	10·45	9·9	5⅜	6½	f/20·54	26·2	f/52	169

$\frac{1}{8}$ = ·125. $\frac{1}{4}$ = ·25. $\frac{3}{8}$ = ·375. $\frac{1}{2}$ = ·5. $\frac{5}{8}$ = ·625. $\frac{3}{4}$ = ·75. $\frac{7}{8}$ = ·825.

Square of Magnification.	Magnification.	DISTANCE FROM THE NEGATIVE LENS TO SCREEN IN INCHES.													Magnification.	Positive Lens at f/3·16	U.S. Number.	Positive Lens at f/8.	U.S. Number.
		6in. Neg. Lens.	5in. Neg. Lens.	4in. Neg. Lens.	3·8in. Neg. Lens.	3·3in. Neg. Lens.	3in. Neg. Lens	2·8in. Neg. Lens.	2 4in. Neg. Lens.	2·25in. Neg. Lens.	2in. Neg. Lens.	1·9in. Neg. Lens.	1·8in. Neg. Lens.	1·75in. Neg. Lens.	1in Neg. Lens.					
43·89	6⅝	33¾	28⅛	22½	21⅜	18·562	16⅝	15¾	13½	12·65	11¼	10·687	10⅛	9·843	5⅝	6⅝	f/20·93	27·3	f/53	175·56
45·56	6¾	34½	28¾	23	21·85	18·975	17⅛	16·1	13·8	12·93	11⅜	10·925	10·35	10·06	5¾	6¾	f/21·33	28·3	f/54	182·25
47·26	6⅞	35¼	29⅜	23½	22·325	19·387	17⅜	16·45	14·1	13·21	11½	11·162	10·28	5⅞	6⅞	f/21·725	20·4	f/55	189·06
49	7	36	30	24	22·8	19·8	18	16·8	14·4	13½	12	11·4	10·8	10½	6	7	f/22·12	30·5	f/56	196
50·76	7⅛	30⅜	30⅝	24½	23·275	20·212	18⅜	17·15	14·7	13·78	12¼	11·637	11·025	10·71	6⅛	7⅛	f/22·58	31·6	f/57	203·06
52·56	7¼	37½	31¼	25	23⅝	20⅝	18¾	17½	15	14·06	12½	11⅞	11⅛	10·93	6¼	7¼	f/22·91	32·7	f/58	210·25
54·39	7⅜	38½	31⅝	25½	24·225	21·037	19⅛	17·85	15·3	14·34	12¾	12·112	11·475	11·15	6⅜	7⅜	f/23·30	33·9	f/59	217·56
56·25	7½	39	32½	26	24·7	21·45	19½	18·2	15·6	14⅝	13	12·35	11·7	11⅜	6½	7½	f/23·7	35·1	f/60	225
58·14	7⅝	39¾	33⅛	26½	25·17	21·862	19¾	18·55	15·9	14·90	13¼	12·587	11·92	11·59	6⅝	7⅝	f/24·09	36·3	f/61	232·56
60·06	7¾	40½	33¾	27	25·65	22·275	20¼	18·9	16·2	15·18	13½	12·825	12·15	11·81	6¾	7¾	f/24·49	37·5	f/62	240·25
62·01	7⅞	41¼	34⅜	27½	26⅛	22·687	20⅝	19¼	16½	15·46	13¾	13·062	12⅜	12·03	6⅞	7⅞	f/24·88	38·7	f/63	248·06
64	8	42	35	28	26·6	23·1	21	19·6	16·8	15¾	14	13·3	12·6	12¼	7	8	f/25·28	39·6	f/64	256
61·01	8⅛	42¾	35⅝	28½	27·07	23·512	21⅜	19·95	17·1	16·03	14¼	13·537	12·82	12·46	7⅛	8⅛	f/25·67	40·9	f/65	264·06
68·06	8¼	43½	36¼	29	27·55	23·925	21¾	20·3	17·4	16·31	14½	13·775	13·05	12·68	7¼	8¼	f/26·07	42·5	f/66	272·25
70·14	8⅜	44¼	36⅞	29½	28·02	24·337	22¼	20·65	17·7	16·59	14¾	14·012	13·27	12·90	7⅜	8⅜	f/26·46	43·5	f/67	280·56
72·25	8½	45	37½	30	28½	24⅜	22½	21	18	16⅞	15	14¼	13½	13⅛	7½	8½	f/26·86	44·8	f/68	289
74·39	8⅝	45¾	38⅛	30½	28·97	25·102	22¾	21·35	18·3	17·15	15¼	14·487	13·72	13·34	7⅝	8⅝	f/27·25	46·2	f/69	297·56
76·56	8¾	46½	38¾	31	29·45	25·575	23¼	21·7	18·6	17·43	15½	14·725	13·95	13·56	7¾	8¾	f/27·65	47·6	f/70	306·25
78·76	8⅞	47¼	39⅜	31½	29·92	25·987	23⅝	22·05	18·9	17·71	15¾	14·962	14·17	13·78	7⅞	8⅞	f/28·04	49	f/71	315·06
81	9	48	40	32	30·4	26·4	24	22·4	19·2	18	16	15·2	14·4	14	8	9	f/28·44	50·4	f/72	324
83·26	9⅛	48¾	40⅝	32½	30⅞	26·812	24⅜	22¾	19½	18·28	16¼	15·437	14⅝	14·21	8⅛	9⅛	f/28·83	51·8	f/73	333·06
85·56	9¼	49½	41¼	33	31·35	27·225	24¾	23·1	19·8	18·56	16½	15·675	14·85	14·43	8¼	9¼	f/29·23	53·2	f/74	342·25
87·89	9⅜	50¼	41⅞	33½	31·82	27·637	25¼	23·45	20·1	18·84	16¾	15·912	15·07	14·65	8⅜	9⅜	f/29·62	54·7	f/75	351·56
90·25	9½	51	42½	34	32·3	28·05	25½	23·8	20·4	19¼	17	16·15	15·3	14⅞	8½	9½	f/30·02	56·2	f/76	361
92·64	9⅝	51¾	43⅛	34½	32·77	28·462	25⅞	24·15	20·7	19·40	17¼	16·387	15·52	15·09	8⅝	9⅝	f/30·41	57·7	f/77	370·56
95·06	9¾	52½	43¾	35	33¼	28·875	26¼	24½	21	19·68	17½	16⅝	15⅞	15·31	8¾	9¾	f/30·81	59·2	f/78	380·25
97·51	9⅞	53¼	44⅜	35½	33·72	29·287	26⅝	24·85	21·3	19·96	17⅞	16·862	15·97	15·53	8⅞	9⅞	f/31·20	60·8	f/79	390·06
100	10	54	45	36	34·2	29·7	27	25·2	21·6	20¼	18	17·1	16·2	15¾	9	10	f/31·6	62·4	f/80	400
102·51	10⅛	54¾	45⅝	36½	34·67	30·112	27⅜	25·55	21·9	20·53	18¼	17·337	16·42	15·96	9⅛	10⅛	f/31·99	64	f/81	410·06
105·06	10¼	55½	46¼	37	35·15	30·525	27¼	25·9	22·2	20·81	18½	17·575	16·65	16·18	9¼	10¼	f/32·39	65·2	f/82	420·25
107·64	10⅜	56¼	46⅞	37½	35⅝	30·937	28⅛	26¼	22½	21·09	18¾	17·812	16⅞	16·40	9⅜	10⅜	f/32·78	67·2	f/83	430·56
110·25	10½	57	47½	38	36·1	31·35	28½	26·6	22·8	21⅜	19	18·05	17·1	16⅞	9½	10½	f/33·18	68·9	f/84	441

⅛ = ·125. ¼ = ·25. ⅜ = ·375. ½ = ·5. ⅝ = ·625. ¾ = ·75. ⅞ = ·825.

Square of Magnification.	Magnification.	DISTANCE FROM THE NEGATIVE LENS TO SCREEN IN INCHES.														Magnification.	Positive Lens at f/3·16	U. S. Number.	Positive lens at f/8	U. S. Number.
		6in. Neg. Lens.	5in. Neg. Lens.	4in. Neg. Lens.	3·5in. Neg. Lens.	3in. Neg. Lens.	2·8in. Neg. Lens.	2·4in. Neg. Lens.	2·25in. Neg. Lens.	2in. Neg. Lens.	1·9in. Neg. Lens.	1·8in. Neg. Lens.	1·75in. Neg. Lens.	1in. Neg. Lens.						
112·89	10⅝	57¾	48¼	38¼	36·57	31·762	26·95	23·1	21·65	19¼	18·287	17·32	16·84	9⅝	10⅝	f/33·57	70·1	451·56	f/85	451·56
115·56	10¾	58¾	48¾	39	37·05	32·175	27·3	23·4	21·93	19½	18·525	17·55	17·06	9¾	10¾	f/33·97	72·2	462·25	f/86	462·25
118·26	10¾	59¼	49⅛	39½	37·52	32·587	27·65	23·7	22·21	19¾	18·762	17·77	17·28	9⅞	10¾	f/34·36	73·5	473·06	f/87	473·06
121	11	60	50	40	38	33	28	24	22½	20	19	18	17½	10	11	f/34·76	75·2	484	f/88	484
123·76	11¼	60¾	50⅝	40½	38·47	33·412	28·35	24·3	22·78	20¼	19·237	18·45	17·71	10⅛	11¼	f/35·15	77	495·06	f/89	495·06
121·56	11⅜	61¾	51¼	41	38·95	33·825	28·7	24·6	23·06	20½	19·475	18·67	17·93	10¼	11⅜	f/35·55	78·8	506·25	f/90	506·25
129·39	11⅜	62¼	51¾	41½	39·42	34·237	29·05	24·9	23·34	20¾	19·712	18·907	18·15	10⅜	11⅜	f/35·94	81	517·56	f/91	517·56
132·25	11½	63	52½	42	39·9	34·65	29·4	25·2	23·8	21	19·95	18·9	18·2	10½	11½	f/36·34	82·3	529	f/92	529
135·14	11⅝	63¾	53¼	42¾	40·3	35·062	29·8	25·1	23·90	21¼	20·187	19·35	18·59	10⅝	11⅝	f/36·73	84·2	540·56	f/93	540·56
138·06	11¾	64½	53¾	43	40·85	35·475	30·2	25·8	24·18	21½	20·425	19·57	18·81	10¾	11¾	f/37·13	86	552·25	f/94	552·25
141·01	11⅞	65¼	54⅜	43½	41·32	35·887	30·45	26·1	24·46	21¾	20·662	19·57	19·03	10⅞	11⅞	f/37·52	87·8	564·06	f/95	564·06
144	12	66	55	44	41·8	36·3	30·8	26·4	24⅜	22	20·9	19·8	19¼	11	12	f/37·92	89·7	576	f/96	576
147·01	12¼	66¾	55⅝	44½	42·27	36·712	31·15	26·7	25·03	22¼	21·137	20·02	19·46	11⅛	12¼	f/38·31	91·6	588·06	f/97	588·06
150·06	12½	67½	56¼	45	43·23	37·4	31·8	27·3	25·31	22½	21·375	20¼	19·68	11¼	12½	f/38·71	93·6	600·25	f/98	600·25
153·11	12¾	68¼	56¾	45½	43·22	37·537	31·85	27·4	25·59	22¾	21·612	20·47	19·90	11⅜	12¾	f/39·1	95·5	612·56	f/99	612·56
156·25	13	69	57½	46	43·7	37·95	32·2	27·6	25·4	23	21·85	20·7	20·2	11½	12½	f/39·5	97·5	625	f/100	625
159·39	12⅝	69¾	58¼	46¼	44·17	38·362	32·55	27·9	26·15	23¼	22·08	20·92	20·34	11⅝	12⅝	f/39·89	99·5	637·56	f/101	637·56
162·56	12¾	70¾	58¾	47	44·65	38·775	32·9	28·2	26·43	23½	22·32	21·15	20·56	11¾	12¾	f/40·29	101·5	650·25	f/102	650·25
165·76	12⅞	71¾	59⅝	47¼	45·8	39·187	33¼	28·8	26·71	23¾	22·56	21·37	20·78	11⅞	12⅞	f/40·68	103	663·06	f/103	663·06
169	13	72	60	48	45·6	39·6	33·6	28·8	27	24	22·8	21·6	21	12	13	f/41·08	105·5	676	f/104	676
172·26	13⅛	72¾	60⅝	48½	46·07	40·01	33·95	29·1	27·28	24¼	23·03	21·82	21·21	12⅛	13⅛	f/41·75	108·6	689·06	f/105	689·06
175·56	13⅛	73¾	61¼	49	46·55	40·42	34·3	29·4	27·56	24½	23·27	22·05	21·43	12¼	13⅛	f/41·97	109·2	702·25	f/106	702·25
178·89	13⅜	74¼	61¾	49½	47·02	40·83	34·65	29·7	27·84	24¾	23·51	22·27	21·65	12⅜	13⅜	f/42·26	111·3	715·56	f/107	715·56
182·25	13⅝	75	62½	50	47·5	41·1	35	30	28·4	25	23·75	22·5	21·7	12½	13⅝	f/42·66	113·4	729	f/108	729
185·64	13⅝	75¾	63¼	50½	47·97	41·66	35·35	30·3	28·40	25¼	23·98	22·72	22·09	12⅝	13⅝	f/43·05	115·5	742·56	f/109	742·56
189·06	13¾	76½	63¾	51	48·45	42·07	35·7	30·6	28·68	25½	24·22	22·95	22·31	12¾	13¾	f/43·45	117·7	756·25	f/110	756·25
192·51	13⅞	77¼	64⅜	51½	48·92	42·48	36·05	30·9	28·96	25¾	24·46	23·17	22·53	12⅞	13⅞	f/43·84	119·9	770·06	f/111	770·06
196	14	78	65	52	49·4	42·9	36·4	31·2	29·4	26	24·7	23·4	22·8	13	14	f/44·24	122·1	784	f/112	784
199·51	14⅛	78¾	65⅝	52½	49·4	43·31	36·8	31·4	29·53	26¼	24·93	23·8	22·96	13⅛	14⅛	f/44·63	124·3	798·06	f/113	798·06
203·06	14¼	79¾	66¼	53	50·35	43·72	37·1	31·8	29·81	26½	25·17	23·85	23·18	13¼	14¼	f/45·03	126·5	812·25	f/114	812·25
206·64	14⅜	80¼	66¾	53¼	50·82	44·13	37·45	32·2	30·09	26¾	25·41	24·07	23·40	13⅜	14⅜	f/45·42	128·8	826·56	f/115	826·56
210·25	14½	81	67½	54	51·3	44·55	37·8	32·4	30·38	27	25·65	24·3	23·8	13½	14½	f/45·82	131·1	841	f/116	841

$\frac{1}{8}$ = ·125. $\frac{1}{4}$ = ·25. $\frac{3}{8}$ = ·375. $\frac{1}{2}$ = ·5. $\frac{5}{8}$ = ·625. $\frac{3}{4}$ = ·75. $\frac{7}{8}$ = ·825.

Square of Magnification.	Magnification.	DISTANCE FROM THE NEGATIVE LENS TO THE SCREEN IN INCHES.														Magnification.	Positive Lens at f/3·16.	U.S. Number.	Positive Lens at f/8.	U.S. Number.
		6in. Neg. Lens.	5in. Neg. Lens.	4in. Neg. Lens.	3·5in. Neg. Lens.	3in. Neg. Lens.	2·5in. Neg. Lens.	2·25in. Neg. Lens.	2in. Neg. Lens.	1·9in. Neg. Lens.	1·75in. Neg. Lens.	1·5in. Neg. Lens.								
		$\frac{1}{8} = \cdot125$.		$\frac{1}{4} = \cdot25$.		$\frac{3}{8} = \cdot375$.		$\frac{1}{2} = \cdot5$.		$\frac{5}{8} = \cdot625$.		$\frac{3}{4} = \cdot75$.		$\frac{7}{8} = \cdot825$.						
213·89	14⅝	8⅛	6⅞	5⅜	4⅞	4⅜	3⅞	3⅝	3⅜	3⅛	2⅞	2¾	2⅝	2½	2⅜	14⅝	f/4·621	133·4	f/117	855·56
217·56	14¾	8⅛	6⅞	5⅜	4⅞	4⅜	3⅞	3⅝	3⅜	3⅛	2⅞	2¾	2⅝	2½	2⅜	14¾	f/4·661	135·7	f/118	870·25
221·26	14⅞	8⅜	6⅞	5⅜	4⅞	4⅜	3⅞	3⅝	3⅜	3⅛	2⅞	2¾	2⅝	2½	2⅜	14⅞	f/4·700	138	f/119	885·06
225	15	8½	7	5⅝	5	4½	4	3⅞	3½	3⅛	3	2⅞	2¾	2⅝	2½	15	f/4·74	140·4	f/120	900
228·76	15⅛	8⅝	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15⅛	f/4·779	142·8	f/121	915·06
232·56	15⅜	8¾	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15⅜	f/4·819	145	f/122	930·25
236·39	15⅝	8¾	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15⅝	f/4·858	147	f/123	945·56
240·25	15½	8¾	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15½	f/4·898	150	f/124	961
244·14	15⅞	8⅞	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15⅞	f/4·937	151·9	f/125	976·56
248·06	15¾	8⅞	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15¾	f/4·977	154·4	f/126	992·25
252·01	15⅞	8⅞	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15⅞	f/5·016	156·8	f/127	1008·06
256	16	9	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16	f/5·056	159·3	f/128	1024
260·01	16⅛	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16⅛	f/5·095	162	f/129	1040·06
264·06	16½	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16½	f/5·135	164·5	f/130	1056·25
268·14	16⅝	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16⅝	f/5·174	167	f/131	1072·56
272·25	16½	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16½	f/5·214	169·6	f/132	1089
276·39	16⅝	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16⅝	f/5·253	172·2	f/133	1105·56
280·56	16¾	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16¾	f/5·293	174·9	f/134	1122·25
284·76	16⅞	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16⅞	f/5·332	177·5	f/135	1139·06
289	17	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17	f/5·372	180·2	f/136	1156
293·26	17⅛	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17⅛	f/5·411	182·9	f/137	1173·06
297·56	17⅜	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17⅜	f/5·451	185·6	f/138	1190·25
301·89	17⅝	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17⅝	f/5·49	188·3	f/139	1207·56
306·25	17½	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17½	f/5·53	191·1	f/140	1225
310·64	17⅝	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17⅝	f/5·569	193·2	f/141	1242·56
315·06	17¾	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17¾	f/5·609	196·7	f/142	1260·25
319·51	17⅞	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17⅞	f/5·648	198·8	f/143	1278·06
324	18	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	18	f/5·688	201·6	f/144	1296
328·51	18⅛	10⅛	8⅛	6⅛	5⅛	5⅛	4⅛	4	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	18⅛	f/5·727	204·5	f/145	1314·06
333·06	18¼	10⅛	8⅛	6⅛	5⅛	5⅛	4⅛	4	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	18¼	f/5·767	207·3	f/146	1332·25
337·64	18⅜	10⅛	8⅛	6⅛	5⅛	5⅛	4⅛	4	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	18⅜	f/5·806	210·2	f/147	1350·56
342·25	18½	10⅛	8⅛	6⅛	5⅛	5⅛	4⅛	4	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	18½	f/5·846	213·1	f/148	1369
213·89	14⅝	8⅛	6⅞	5⅜	4⅞	4⅜	3⅞	3⅝	3⅜	3⅛	2⅞	2¾	2⅝	2½	2⅜	14⅝	f/4·621	133·4	f/117	855·56
217·56	14¾	8⅛	6⅞	5⅜	4⅞	4⅜	3⅞	3⅝	3⅜	3⅛	2⅞	2¾	2⅝	2½	2⅜	14¾	f/4·661	135·7	f/118	870·25
221·26	14⅞	8⅜	6⅞	5⅜	4⅞	4⅜	3⅞	3⅝	3⅜	3⅛	2⅞	2¾	2⅝	2½	2⅜	14⅞	f/4·700	138	f/119	885·06
225	15	8½	7	5⅝	5	4½	4	3⅞	3½	3⅛	3	2⅞	2¾	2⅝	2½	15	f/4·74	140·4	f/120	900
228·76	15⅛	8⅝	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15⅛	f/4·779	142·8	f/121	915·06
232·56	15⅜	8¾	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15⅜	f/4·819	145	f/122	930·25
236·39	15⅝	8¾	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15⅝	f/4·858	147	f/123	945·56
240·25	15½	8¾	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15½	f/4·898	150	f/124	961
244·14	15⅞	8⅞	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15⅞	f/4·937	151·9	f/125	976·56
248·06	15¾	8⅞	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15¾	f/4·977	154·4	f/126	992·25
252·01	15⅞	8⅞	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	15⅞	f/5·016	156·8	f/127	1008·06
256	16	9	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16	f/5·056	159·3	f/128	1024
260·01	16⅛	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16⅛	f/5·095	162	f/129	1040·06
264·06	16½	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16½	f/5·135	164·5	f/130	1056·25
268·14	16⅝	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16⅝	f/5·174	167	f/131	1072·56
272·25	16½	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16½	f/5·214	169·6	f/132	1089
276·39	16⅝	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16⅝	f/5·253	172·2	f/133	1105·56
280·56	16¾	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16¾	f/5·293	174·9	f/134	1122·25
284·76	16⅞	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	16⅞	f/5·332	177·5	f/135	1139·06
289	17	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17	f/5·372	180·2	f/136	1156
293·26	17⅛	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17⅛	f/5·411	182·9	f/137	1173·06
297·56	17⅜	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17⅜	f/5·451	185·6	f/138	1190·25
301·89	17⅝	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17⅝	f/5·49	188·3	f/139	1207·56
306·25	17½	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17½	f/5·53	191·1	f/140	1225
310·64	17⅝	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17⅝	f/5·569	193·2	f/141	1242·56
315·06	17¾	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17¾	f/5·609	196·7	f/142	1260·25
319·51	17⅞	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	17⅞	f/5·648	198·8	f/143	1278·06
324	18	9⅛	7⅛	5¾	5⅛	4⅝	4⅛	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	2⅝	18	f/5·688	201·6	f/144	1296
328·51	18⅛	10⅛	8⅛	6⅛	5⅛	5⅛	4⅛	4	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	18⅛	f/5·727	204·5	f/145	1314·06
333·06	18¼	10⅛	8⅛	6⅛	5⅛	5⅛	4⅛	4	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	18¼	f/5·767	207·3	f/146	1332·25
337·64	18⅜	10⅛	8⅛	6⅛	5⅛	5⅛	4⅛	4	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	18⅜	f/5·806	210·2	f/147	1350·56
342·25	18½	10⅛	8⅛	6⅛	5⅛	5⅛	4⅛	4	3⅞	3⅝	3⅜	3⅛	3	2⅞	2¾	18½	f/5·846	213·1	f/148	1369

*Square of Magnification.	Magnification.	DISTANCE FROM THE NEGATIVE LENS TO SCREEN.												Magnification.	Positive Lens at f/3·76.	†U.S. Number.	Positive Lens at f/8.	*U.S. Number.
		6in. Neg. Lens.	5in. Neg. Lens.	4in. Neg. Lens.	3·8in. Neg. Lens.	3·3in. Neg. Lens.	3in. Neg. Lens.	2·8in. Neg. Lens.	2·4in. Neg. Lens.	2·25in. Neg. Lens.	2in. Neg. Lens.	1·9in. Neg. Lens.	1·8in. Neg. Lens.	1·75in. Neg. Lens.	1in. Neg. Lens.			
346·89	18⅝	105⅜	88⅜	70½	66·97	58·16	52·6	49·35	42·3	39·65	35¼	33·48	31·72	29·84	17⅝	18⅝	f/58·85	216	f/149	1387·56
351·56	18¾	106⅛	88⅔	71	67·45	58·57	53¼	49·7	42·6	39·93	35½	33·72	31·95	30·06	17¾	18¾	f/59·25	219	f/150	1406·25
356·26	18⅞	107¼	89⅓	71½	67·92	58·98	53⅜	50·05	42·9	40·21	35¾	33·96	32·17	30·28	17⅞	18⅞	f/59·64	222	f/151	1425·06
361	19	108	90	72	68·4	59·4	54	50·4	43·2	40½	36	34·2	32·4	30½	18	19	f/60·04	225	f/152	1444
365·76	19¼	108⅜	90⅝	72½	68⅞	59·81	54⅜	50⅜	43½	40·78	36¼	34·63	32⅝	30·71	18⅜	19¼	f/60·43	228	f/153	1463·06
370·56	19½	109⅛	91¼	73	69·35	60·22	54⅝	51·1	43⅝	41·06	36½	34·47	32·95	30·93	18¾	19½	f/60·83	231	f/154	1482·25
375·39	19¾	109⅞	91¾	73¼	69·82	60·63	55¼	51·45	44·1	41·34	36⅞	34·91	33·07	31·15	18⅞	19¾	f/61·22	234	f/155	1501·56
380·25	19½	111	92½	74	70·3	61·05	55½	51·8	44·4	41⅝	37	35·15	33·3	31⅛	19	19½	f/61·62	237·1	f/156	1521
385·14	19⅝	111⅜	93¼	74½	70·77	61·46	55⅞	52·15	44·7	41·90	37¼	35·38	33·52	31·59	19⅛	19⅝	f/62·01	240·2	f/157	1540·56
390·06	19¾	112½	93⅝	75	71·14	61·87	56¼	52·5	45·	42·18	37½	35⅝	33⅞	31·81	19¼	19¾	f/62·41	243·3	f/158	1560·25
395·01	19⅞	113¼	94⅜	75½	71·72	62·28	56⅝	52·95	45·3	42·46	37¾	35·86	33·97	32·03	19⅜	19⅞	f/62·8	246·4	f/159	1580·06
400	20	114	95	76	72·2	63·7	57	53·2	45·6	42·¾	38	36·1	34·2	32¼	19	20	f/63·2	249·6	f/160	1600

$\frac{1}{16}$ = ·125. $\frac{1}{4}$ = ·25. $\frac{3}{8}$ = ·375. $\frac{1}{2}$ = ·5. $\frac{5}{8}$ = ·625. $\frac{3}{4}$ = ·75. $\frac{7}{8}$ = ·825.

† The values given in this column are sufficiently accurate, the margin of error is less than one per cent.

* The values in this column are correct to two places of decimals as given.

Decimal fractions in these columns are correct to three places at the commencement, but later, where the decimals repeat two places have been considered sufficient. For example, the measurements for the negative lens 2·25 focus are given to three places of decimals up to $6\frac{3}{8}$ magnifications, after this point, to two places only; the decimal fractions for $6\frac{5}{8}$, $10\frac{3}{8}$, $14\frac{5}{8}$, $18\frac{3}{8}$ magnifications are the same as for $2\frac{5}{8}$. When a measurement is given in a vulgar fraction, it is exact, not approximate.

TABLE III.

Metrical Measure.

Magnifications of telephotographic lenses at various extensions of the camera, setting forth the requisite distance from the negative lens to the screen, for magnifications of two and a half to twenty times inclusive, ascending by magnifications of one-eighth.

For the rapidity of the telephoto lens at varying magnifications the reader should refer to Table II. if the positive lens has an equivalent aperture of f/3·16 or f/8, to Table IV. if the positive lens has an equivalent aperture of f/9.

This table is designed for use with the following negative lenses or others of similar focal length:

Messrs. Clément and Gilmer.

No. 0 focus 60 mm.

0 bis / 1 } focus 80 mm.

Messrs. Steinheil and Söhne.

Nos. 1 and 2 focus 48 mm.
,, 3 and 4 ,, 67·5 ,,
,, 5 ,, 75 ,,
,, 6 and 7 ,, 90 ,,
,, 8 ,, 135 ,,

Messrs. J. H. Dallmeyer, Ltd.

4 inch focus = 100 mm.
5 ,, ,, = 125 ,,

Messrs. Voigtländer and Sohn.

No. 1 focus 40 mm.
,, 2 ,, 60 ,,
,, 3 ,, 80 ,,
,, 4 ,, 120 ,,

Messrs. Ross Ltd.

See Messrs. Carl Zeiss.

Messrs. Carl Zeiss.

No. 1 focus 27 mm.
,, 2 ,, 45 ,,
,, 3 ,, 58 ,,
,, 4 ,, 75 ,,
,, 5 ,, 100 ,,
,, 6 125 ,,

DISTANCE FROM THE NEGATIVE LENS TO THE SCREEN IN CENTIMETRES.																Magnification.	Square of Magnification.
150 mm. Neg. Lens.	140 mm. Neg. Lens.	135 mm. Neg. Lens.	125 mm. Neg. Lens.	120 mm. Neg. Lens.	100 mm. Neg. Lens.	90 mm. Neg. Lens.	80 mm. Neg. Lens.	75 mm. Neg. Lens.	67·5 mm. Neg. Lens.	60 mm. Neg. Lens.	58 mm. Neg. Lens.	48 mm. Lens.	45 mm. Neg. Lens.	40 mm. Neg. Lens.	27 mm. Neg. Lens.		
22·5	21	20·25	18·75	18	15	13·50	12	11·25	10·12	9	8·70	7·20	6·75	6	4·05	2½	6·25
24·37	22·75	21·93	20 31	19·50	16·25	14·62	13	12·18	10·68	9·75	9·42	7·80	7·31	6·50	4·38	2 5/8	6·89
26·25	24·50	23·62	21·87	21	17·50	15·75	14	13·12	11·81	10·50	10·15	8·40	7·87	7	4·72	2¾	7·56
28·12	26·25	25·31	23·43	22·50	18·75	16·87	15	14·06	12·65	11·25	10·87	9	8·43	7·50	5·06	2 7/8	8·26
30	28	27	25	24	20	18	16	15	13·50	12	11·60	9·60	9	8	5·40	3	9
31·87	29·75	28 68	26 56	25·50	21·25	19 12	17	15·93	14·34	12·75	12·32	10·20	9·56	8·50	5·73	3 1/8	9·76
33·75	31·50	30·37	28 12	27	22·50	20·25	18	16·87	15·18	13·50	13·05	10·80	10·12	9	6·07	3¼	10·56
35·62	33·25	32·06	29·68	28·50	23·75	21·37	19	17·81	16·03	14 25	13·77	11·40	10·68	9·50	6·41	3 3/8	11·39
37·50	35	33·75	31·25	30	25	22·50	20	18·75	16·87	15	14·50	12	11·25	10	6·75	3½	12·25
39·37	36·75	35·43	32 81	31·50	26·25	23·62	21	19·68	17·71	15·75	15 22	12 60	11·81	10·50	7·08	3 5/8	13·14
41·25	38·50	37·12	34·37	33	27·50	24·75	22	20·62	18·56	16·50	15·95	13·20	12·37	11	7·42	3¾	14·06
43·12	40 25	38·81	35·93	34·50	28 75	25 87	23	21·56	19·40	17 25	16·67	13 80	12 93	11·50	7·76	3 7/8	15·01
45	42	40·50	37·50	36	30	27	24	22·50	20 25	18	17·40	14·40	13·50	12	8·10	4	16
46·87	43·75	42 18	39·06	37·50	31·25	28·12	25	23·43	21·09	18·75	18·12	15	14·06	12·50	8·43	4 1/8	17·01
48·75	45·50	43·87	40 62	39	32·50	29·25	26	24·37	21·93	19·50	18·85	15·60	14·62	13	8·77	4¼	18·06
50·62	47 25	45·56	42·18	40·50	33·75	30·37	27	25·31	22·78	20·25	19·57	16·20	15·18	13 50	9·11	4 3/8	19·14
52·50	49	47·25	43·75	42	35	31·50	28	26·25	23·62	21	20·30	16·80	15·75	14	9·45	4½	20·25
54·37	50·75	48·93	45 31	43·50	36 25	32 62	29	27·18	24·46	21·75	21·02	17·40	16·31	14·50	9·78	4 5/8	21·39
56·25	52·50	50·62	46·87	45	37·50	33·75	30	28·12	25·31	22·50	21·75	18	16 87	15	10·12	4¾	22·56
58·12	54 25	52·31	48·43	46 50	38 75	34·87	31	29 06	26·15	23 25	22·47	18·60	17·43	15·50	10·46	4 7/8	23·76
60	56	54	50	48	40	36	32	30	27	24	23·20	19·20	18	16	10·80	5	25
61·87	57·75	55·68	51·56	49 50	41 25	37·12	33	30·93	27·84	24·75	23·92	19·80	18·56	16·50	11·13	5 1/8	26·26
63·75	59·50	57·37	53·12	51	42·50	38·25	34	31·87	28·68	25 50	24·65	20·40	19·12	17	11·47	5¼	27·56
65·62	61·25	59·06	54 68	52·50	43·75	39·37	35	32·81	29·53	26·25	25·37	21	19·68	17·50	11·81	5 3/8	28·89
67·50	63	60·75	56·25	54	45	40 50	36	33·75	30·37	27	26·10	21·60	20·25	18	12·15	5½	30·25
69·37	64·75	62·43	57·81	55·50	46 25	41·62	37	34·68	31·28	27·75	26 82	22·20	20 81	18·50	12·48	5 5/8	31·64
71 25	66 50	64·12	59·37	57	47·50	42·75	38	35·62	32·06	28·50	27·55	22·80	21·37	19	12·82	5¾	33·06
73·12	68·25	65·81	60·93	58·50	48·75	43·87	39	36·56	32·90	29 25	28·27	23·40	21·93	19·50	13·16	5 7/8	34·51
75	70	67·50	62·50	60	50	45	40	37 50	33·75	30	29	24	22·50	20	13·50	6	36
76·87	71·75	69·18	64·06	61·50	51·25	46·12	41	38 43	34·59	30·75	29·72	24·60	23·06	20·50	13·83	6⅛	37·51
78·75	73·50	70·87	65·62	63	52·50	47·25	42	39·37	35·43	31·50	30·45	25·20	23·62	21	14·17	6¼	39·06
80 62	75·25	72·56	67·18	64·50	53·75	48·37	43	40·31	36·28	32·25	31·17	25·80	24·18	21·50	14·51	6⅜	40·64
82·50	77	74·25	68·75	66	55	49·50	44	41·25	37·12	33	31·90	26·40	24 75	22	14·85	6½	42·25

⅛ = ·125. ¼ = ·25. ⅜ = ·375. ½ = ·5. ⅝ = ·625. ¾ = ·75. ⅞ = ·825.

DISTANCE FROM THE NEGATIVE LENS TO THE SCREEN IN CENTIMETRES.																Magnification.	Square of Magnification.
150 mm. Neg. Lens.	140 mm. Neg. Lens.	135 mm. Neg. Lens.	125 mm. Neg. Lens.	120 mm. Neg. Lens.	100 mm. Neg. Lens.	90 mm. Neg. Lens.	80 mm. Neg. Lens.	75 mm. Neg. Lens.	67·5 mm. Neg. Lens.	60 mm. Neg. Lens.	58 mm. Neg. Lens.	48 mm. Neg. Lens.	45 mm. Neg. Lens.	40 mm. Neg. Lens.	27 mm. Neg. Lens.		
84·37	78·75	75·93	70·31	67·50	56·25	50·62	45	42·18	37·69	33 75	32·62	27	25·31	22·50	15·18	6⅝	43·89
86·25	80·50	77·62	71·87	69	57·50	51·75	46	43·12	38·81	34·50	33·35	27·60	25·87	23	15·52	6¾	45·56
88·12	82·25	79·31	73·43	70·50	58·75	52·87	47	44·06	39·65	35·25	34·07	28·20	26 43	23·50	15 86	6⅞	47·26
90	84	81	75	72	60	54	48	45	40·50	36	34·80	28·80	27	24	16 20	7	49
91·87	85·75	82·68	76·56	73·50	61·25	55·12	49	45·93	41·34	36·75	35 52	29 40	27·56	24·50	16·53	7⅛	50·76
93·75	87·50	84·37	78·12	75	62·50	56·25	50	46·87	42·18	37·50	36·25	30	28·12	25	16·87	7¼	52·56
95·62	89·25	86·06	79·68	76·50	63·75	57·37	51	47·81	43·03	38·25	36·97	30·60	28·68	25·50	17·21	7⅜	54 39
97·50	91	87·75	81·25	78	65	58·50	52	48·75	43·87	39	37·70	31·20	29·25	26	17 55	7½	56 25
99·37	92·75	89·43	82·81	79·50	66·25	59·62	53	49·68	44·71	39·75	38·42	31·80	29·81	26,50	17·88	7⅝	58·14
101·25	94·50	91·12	84·37	81	67·50	60·75	54	50·62	45·56	40·50	39·15	32·40	30·37	27	18·22	7¾	60·06
103·12	96·25	92·81	85·93	82·50	68·75	61·87	55	51·56	46·40	41·25	39·87	33	30·93	27·50	18·56	7⅞	62·01
105	98	94·50	87·50	84	70	63	56	52·50	47·25	42	40·60	33·60	31·5c	28	18·90	8	64
106·87	99·75	96·18	89·06	85·50	71·25	64·12	57	53·43	48·09	42·75	41·32	34·20	32·06	28·50	19·23	8⅛	61·01
108·75	101·50	97·87	90·62	87	72·50	65·25	58	54·37	48·93	43·50	42·05	34·80	32·62	29	19·57	8¼	68·06
110·62	103·25	99·56	92·18	88·50	73·75	66·37	59	55·31	49·78	44·25	42·77	35·40	33 18	29·50	19·91	8⅜	70·14
112·50	105	101·25	93·75	90	75	67·50	60	56·25	50·62	45	43·50	36	33 75	30	20·25	8½	72·25
114·37	106·75	102·93	95·31	91·50	76·25	68·62	61	57·18	51·46	45·75	44·22	36·60	34·31	30·50	20·58	8⅝	74·39
116·25	108·50	104·62	96·87	93	77·50	69·75	62	58·12	52·31	46·50	44·95	37·20	34·87	31	20·92	8¾	76·56
118·12	110·25	106·31	98·43	94·50	78·75	70·87	63	59·06	53 15	47·25	45·67	37·80	35·43	31 50	21·26	8⅞	78·76
120	112	108	100	96	80	72	64	60	54	48	46·40	38·40	36	32	21·60	9	81
121·87	113·75	109·68	101·56	97·50	81·25	73·12	65	60·93	54·84	48·75	47·12	39	36·56	32 50	21·93	9⅛	83·26
123·75	115·50	111·37	103·12	99	82·50	74·25	66	61·87	55·68	49·50	47·85	39·60	37·12	33	22·27	9¼	85·56
125·62	117·25	113·06	104·68	100·50	83·75	75·37	67	62·81	56 53	50·25	48·57	40·20	37·68	33·50	22 61	9⅜	87·89
127·50	119	114·75	106·25	102	85	76·50	68	63·75	57·37	51	49·30	40·80	38·25	34	22·95	9½	90·25
129·37	120·75	116·43	107·81	103·50	86·25	77·62	69	64·68	58·28	51·75	50·02	41·40	38·81	34·50	23·28	9⅝	92·64
131·25	122·50	118·12	109·37	105	87·50	78·75	70	65·62	59·06	52·50	50·75	42	39 37	35	23 62	9¾	95·06
133·12	124·25	119·81	110·93	106·50	88·75	79·87	71	66·56	59·90	53·25	51·47	42·60	39 93	35 50	23·96	9⅞	97·51
135	126	121·50	112·50	108	90	81	72	67·50	60·75	54	52·20	43·20	40·50	36	24·30	10	100
136·87	127·75	123·18	114·06	109·50	91·25	82·12	73	68·43	61·59	54·75	52·92	43·80	41·06	36·50	24·63	10⅛	102·51
138·75	129·50	124·87	115·62	111	92·50	83·25	74	69·37	62·43	55·50	53·65	44·40	41·62	37	24 97	10¼	105·06
140·62	131·25	126·56	117·18	112·50	93·75	84·37	75	70·31	63·28	56·25	54·37	45	42·18	37 50	25·21	10⅜	107 64
142·50	133	128·25	118·75	114	95	85·50	76	71·25	64·12	57	55·10	45·60	42·75	38	25·65	10½	110·25

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DISTANCE FROM THE NEGATIVE LENS TO THE SCREEN IN CENTIMETRES.

Magnification.	Square of the Magnification.	27 mm. Neg. Lens.	40 mm. Neg. Lens.	45 mm. Neg. Lens.	48 mm. Neg. Lens.	58 mm. Neg. Lens.	60 mm. Neg. Lens.	67·5 mm. Neg. Lens.	75 mm. Neg. Lens.	80 mm. Neg. Lens.	90 mm. Neg. Lens.	100 mm. Neg. Lens.	120 mm. Neg. Lens.	125 mm. Neg. Lens.	135 mm. Neg. Lens.	140 mm. Neg. Lens.	150 mm. Neg. Lens.
10½	110·25	25·98	38·50	43·31	46·20	55·82	57·75	64·69	72·18	77	86·62	96·25	115·50	120·31	129·93	134·75	144·37
10¾	115·56	26·32	39	43·87	46·80	56·55	58·50	65·81	73·12	78	87·75	97·50	117	121·87	131·62	136·50	146·25
11	121	26·66	39·50	44·43	47·40	57·27	59·25	66·65	74·06	79	88·87	98·75	118·50	123·43	133·31	138·25	148·12
11¼	126·56	27	40	45	48	58	60	67·50	75	80	90	100	120	125	135	140	150
11½	132·25	27·33	40·50	45·56	48·60	58·72	60·75	68·34	75·93	81	91·12	101·25	121·50	126·56	136·68	141·75	151·87
11¾	138·06	27·67	41	46·12	49·20	59·45	61·50	69·18	76·87	82	92·25	102·50	123	128·12	138·37	143·50	153·75
12	144	28·01	41·50	46·68	49·80	60·17	62·25	70·03	77·81	83	93·37	103·75	124·50	129·68	140·06	145·25	155·62
12¼	150·06	28·35	42	47·25	50·40	60·90	63	70·87	78·75	84	94·50	105	126	131·25	141·75	147	157·50
12½	156·25	28·68	42·50	47·81	51	61·62	63·75	71·71	79·68	85	95·62	106·25	127·50	132·81	143·43	148·75	159·37
12¾	162·56	29·02	43	48·37	51·60	62·35	64·50	72·56	80·62	86	96·75	107·50	129	134·37	145·12	150·50	161·25
13	169	29·36	43·50	48·93	52·20	63·07	65·25	73·40	81·56	87	97·87	108·75	130·50	135·93	146·81	152·25	163·12
13½	175·56	29·70	44	49·50	52·80	63·80	66	74·25	82·50	88	99	110	132	137·50	148·50	154	165
13¼	182·25	30·03	44·50	50·06	53·40	64·52	66·75	75·09	83·43	89	100·12	111·25	133·50	139·06	150·18	155·75	166·87
13½	189·06	30·37	45	50·62	54	65·25	67·50	75·93	84·37	90	101·25	112·50	135	140·62	151·87	157·50	168·75
13¾	196	30·71	45·50	51·18	54·60	65·97	68·25	76·78	85·31	91	102·37	113·75	136·50	142·18	153·56	159·25	170·62
14	203·06	31·05	46	51·75	55·20	66·70	69	77·62	86·25	92	103·50	115	138	143·75	155·25	161	172·50
14¼	210·25	31·38	46·50	52·31	55·80	67·42	69·75	78·46	87·18	93	104·62	116·25	139·50	145·31	156·93	162·75	174·37
14½	217·56	31·72	47	52·87	56·40	68·15	70·50	79·31	88·12	94	105·75	117·50	141	146·87	158·62	164·50	176·25
14¾	225·00	32·06	47·50	53·43	57	68·87	71·25	80·15	89·06	95	106·87	118·75	142·50	148·43	160·31	166·25	178·12
15	232·56	32·40	48	54	57·60	69·60	72	81	90	96	108	120	144	150	162	168	180
15¼	240·25	32·77	48·50	54·56	58·20	70·32	72·75	81·84	90·93	97	109·12	121·25	145·50	151·56	163·68	169·75	181·87
15½	248·06	33·07	49	55·12	58·80	71·05	73·50	82·68	91·87	98	110·25	122·50	147	153·12	165·37	171·50	183·75
15¾	256·00	33·41	49·50	55·68	59·40	71·77	74·25	83·53	92·81	99	111·37	123·75	148·50	154·68	167·06	173·25	185·62
16	264·06	33·75	50	56·25	60	72·50	75	84·37	93·75	100	112·50	125	150	156·25	168·75	175	187·50
16¼	272·25	34·08	50·50	56·81	60·60	73·22	75·75	85·28	94·68	101	113·62	126·25	151·50	157·81	170·43	176·75	189·37
16½	280·56	34·42	51	57·37	61·20	73·95	76·50	86·06	95·62	102	114·75	127·50	153	159·37	172·12	178·50	191·25
16¾	289·00	34·76	51·50	57·93	61·80	74·67	77·25	86·99	96·56	103	115·87	128·75	154·50	160·93	173·81	180·25	193·12
17	297·56	35·10	52	58·50	62·40	75·40	78	87·75	97·50	104	117	130	156	162·50	175·50	182	195
17¼	306·25	35·43	52·50	59·06	63	76·12	78·75	88·59	98·43	105	118·12	131·25	157·50	164·06	177·18	183·75	196·87
17½	315·06	35·67	53	59·62	63·60	76·85	79·50	89·43	99·37	106	119·25	132·50	159	165·62	178·87	185·50	198·75
17¾	324·00	36·11	53·50	60·18	64·20	77·57	80·25	90·28	100·31	107	120·37	133·75	160·50	167·18	180·56	187·25	200·62
18	333·06	36·45	54	60·75	64·80	78·30	81	91·12	101·25	108	121·50	135	162	168·75	182·25	189	202·50

$\frac{1}{4}$ = ·125. $\frac{1}{4}$ = ·25. $\frac{3}{8}$ = ·375. $\frac{1}{2}$ = ·5. $\frac{5}{8}$ = ·625. $\frac{3}{4}$ = ·75. $\frac{7}{8}$ = ·825.

DISTANCE FROM THE NEGATIVE LENS TO THE SCREEN IN CENTIMETRES.															Magnification.	Square of the Magnification.
150 mm. Neg. Lens.	140 mm. Neg. Lens.	135 mm. Neg. Lens.	125 mm. Neg. Lens.	120 mm. Neg. Lens.	100 mm. Neg. Lens.	90 mm. Neg. Lens.	80 mm. Neg. Lens.	75 mm. Neg. Lens.	67·5 mm. Neg. Lens.	60 mm. Neg. Lens.	58 mm Neg. Lens.	48 mm. Neg. Lens.	45 mm. Neg. Lens.	40 mm. Neg. Lens.	27 mm. Neg. Lens.		
204·37	190·75	183·93	170·31	163·50	136·25	122·62	109	102·18	91·69	81·75	79·02	65·40	61·31	54·50	36·98	14⅛	213·89
206·25	192·50	185·62	171·87	165	137·50	123·75	110	103·12	92·81	82·50	79·75	66	61·87	55	37·12	14⅛	217·56
208·12	194·25	187·31	173·43	166·50	138·75	124·87	111	104·06	93·65	83·25	80·47	66·60	62·43	55·50	37·46	14¼	221·26
210	196	189	175	168	140	126	112	105	94·50	84	81·20	67.20	63	56	37·80	15	225
211·87	197·75	190·68	176·56	169·50	141·25	127·12	113	105·93	95·34	84·75	81·92	67·80	63·56	56·50	38·13	15⅛	228·76
213·75	199·50	192·37	178·12	171	142·50	128·25	114	106·87	96·18	85·50	82·65	68·40	64·12	57	38·47	15¼	232·56
215·62	201·25	194·06	179·68	172·50	143·75	129·37	115	107·81	97·03	86·25	83·37	69	64.68	57·50	38·81	15⅜	236·39
217·50	203	195 75	181·25	174	145	130·50	116	108·75	97·87	87	84·10	69·60	65·25	58	39·15	15½	240·25
219·37	204·75	197·43	182·81	175·50	146·25	131·62	117	109·68	98·71	87·75	84·82	70·20	65·81	58·50	39·48	15⅝	244·14
221·25	206·50	199·12	184·37	177	147.50	132·75	118	110·62	99·56	88·50	85·55	70·80	66·37	59	39·82	15¾	248·06
223·12	208·25	200·81	185·93	178·50	148·75	133·87	119	111·56	100·40	89·25	86·27	71·40	66·93	59·50	40·16	15⅞	252·01
225	210	202·50	187 50	180	150	135	120	112·50	101·25	90	87	72	67·50	60	40·50	16	256
226·87	211·75	204·18	189·06	181·50	151·25	136·12	121	113·43	102·09	90·75	87·72	72·60	68·06	60·50	40·83	16⅛	260·01
228·75	213·50	205·87	190·62	183	152·50	137·25	122	114.37	102·93	91·50	88·45	73·20	68·62	61	41·17	16¼	264·06
230·62	215·25	207·56	192·18	184·50	153·75	138·37	123	115·31	103·78	92·25	89·17	73·80	69·18	61·50	41·51	16⅜	268·14
232·50	217	209·25	193·75	186	155	139·50	124	116·25	104·62	93	89·90	74·40	69·75	62	41·85	16½	272·25
234·37	218·75	210·93	195·31	187·50	156·25	140·62	125	117·18	105·46	93·75	90·62	75	70·31	62·50	42·18	16⅝	276·39
236·25	220·50	212·62	196 87	189	157·50	141·75	126	118·12	106·31	94·50	91·35	75·60	70·87	63	42·52	16¾	280·56
238·12	222·25	214·31	198·43	190·50	158·75	142·87	127	119·06	107·15	95·25	92·07	76·20	71·43	63·50	42·86	16⅞	284·76
240	224	216	200	192	160	144	128	120	108	96	92·80	76·80	72	64	43·20	17	289
241·87	225·75	217·68	201·56	193·50	161·25	145·12	129	120·93	108·84	96·75	93·52	77·40	72·56	64·50	43·53	17⅛	293·26
243·75	227·50	219·37	203·12	195	162·50	146·25	130	121·87	109·68	97·50	94·25	78	73·12	65	43·87	17¼	297·56
245·62	229·25	221·06	204·68	196·50	163·75	147·37	131	122·81	110·53	98·25	94·97	78·60	73·68	65·50	44·21	17⅜	301·89
247·50	231	222·75	206·25	198	165	148·50	132	123·75	111·37	99	95·70	79·20	74·25	66	44·55	17½	306·25
249·37	232 75	224 43	207·81	199·50	166·25	149·62	133	124·68	112·28	99·75	96·42	79·80	74·81	66·50	44·88	17⅝	310·64
251·25	234 50	226·12	209·37	201	167.50	150·75	134	125·62	113·06	100 50	97·15	80·40	75·37	67	45·22	17¾	315·06
253·12	236·25	227·81	210·93	202·50	168·75	151·87	135	126·56	113·90	101·25	97·87	81	75·93	67·50	45·56	17⅞	319·51
255	238	229·50	212·50	204	170	153	136	127·50	114·75	102	98·60	81·60	76·50	68	45·90	18	324
256·87	239·75	231·18	214·06	205·50	171·25	154·12	137	128·43	115 59	102·75	99·32	82·20	77·06	68·50	46·23	18⅛	328·51
258·75	241·50	232 87	215·62	207	172·50	155·25	138	129·37	116·43	103·50	100·05	82·80	77·62	69	46·57	18¼	333·06
260·62	243 25	234 56	217 18	208·50	173·75	156·37	139	130·31	117·28	104·25	100 77	83·40	78·18	69·50	46·91	18⅜	337·64
262·50	245	236 25	218·75	210	175	157·50	140	131·25	118·12	105	101·50	84	78·75	70	47·25	18½	342·25

$\frac{1}{8}$ = ·125. $\frac{1}{4}$ = ·25. $\frac{3}{8}$ = ·375. $\frac{1}{2}$ = ·5. $\frac{5}{8}$ = ·625. $\frac{3}{4}$ = ·75. $\frac{7}{8}$ = ·825.

TABLE III.

DISTANCE FROM THE NEGATIVE LENS TO THE SCREEN IN CENTIMETRES.

Neg. Lens.	150 mm.	140 mm.	135 mm.	125 mm.	120 mm.	100 mm.	90 mm.	80 mm.	75 mm.	67·5 mm.	60 mm.	58 mm.	48 mm.	45 mm.	40 mm.	27 mm.	Magnification.	Square of the Magnification.
	264·37	246·75	237·93	230·31	217·50	176·25	158·62	141	132·18	118·69	105·75	102·22	84·60	79·31	70·50	47·58	185	346 89
	266·25	248·50	239·62	231·87	213	177·50	159·75	142	133·12	119·81	106·50	102·95	85·20	79·87	71	47·92	183	351·56
	268·12	250·25	241·31	233·43	214·50	178·75	160·87	143	134·06	120·65	107·25	103·67	85·80	80·43	71·50	48·26	182	356·26
	270	252	243	225	216	180	162	144	135	121·50	108	104·40	86·40	81	72	48·60	19	361
	271·87	253·75	244·68	226·56	217·50	181·25	163·12	145	135·93	122·34	108·75	105·12	87	81·56	72·50	48·93	191	365·76
	273·75	255·50	246·37	228·12	219	182·50	164·25	146	136·87	123·18	109·50	105·85	87·60	82·12	73	49·27	191	370·56
	275·62	257·25	248·06	229·68	220·50	183·75	165·37	147	137·81	124·03	110·25	106·57	88·20	82·68	73·50	49·61	193	375·39
	277·50	259	249·75	231·25	222	185	166·50	148	138·75	124·87	111	107·30	88·80	83·25	74	49·95	192	380·25
	279·37	260·75	251·43	232·81	223·50	186·25	167·62	149	139·68	125·71	111·75	108·02	89·40	83·81	74·50	50·28	195	385 14
	281·25	262·50	253·12	234·37	225	187·50	168·75	150	140·62	126·56	112·50	108·75	90	84·37	75	50·62	194	390 06
	283·12	264·25	254·81	235·93	226·50	188·75	169·87	151	141·56	127·40	113·25	109·47	90·60	84·93	75·50	50·96	193	395·01
	285	266	256·50	237·50	228	190	171	152	142·5	128·25	114	110·20	91·20	85·50	76	51·30	20	400

$\frac{1}{4} = ·125$. $\frac{1}{3} = ·25$. $\frac{3}{8} = ·375$. $\frac{1}{2} = ·5$. $\frac{5}{8} = ·625$. $\frac{3}{4} = ·75$. $\frac{7}{8} = ·825$.

Fractions of a millimetre are omitted.

TABLE IV.

Rapidity of telephotographic lenses at various magnifications.

Suitable for all positive lenses having an equivalent aperture of f/9.

The magnification should first be found by the use of Table II. or III., when a reference to this table will give the equivalent aperture of the telephotographic lens and the corresponding U.S. number.

This table may be useful to photographers whose positive lenses are marked with the apertures in use abroad, f/6·3, f/9, f/12, etc.

Magnification.	Positive Lens at f/9.	U. S. Number.	Magnification.	Positive Lens at f/9.	U. S. Number.	Magnification.	Positive Lens at f/9.	U. S. Number.	Magnification.	Positive Lens at f/9.	U. S. Number.	Magnification.	Positive Lens at f/9.	U. S. Number.
2 2	f/22·5	31·64	6 3	f/59·625	222	10 3	f/95·625	572	14 3	f/131·625	1083	18 3	f/167·625	1765
2 2	f/23·625	34·88	6 3	f/60·75	231	10 3	f/96·75	585	14 3	f/132·75	1102	18 3	f/168·75	1789
2 2	f/24·75	38·31	6 3	f/61·875	239	10 3	f/98·875	598	14 3	f/133·875	1120	18 3	f/169·875	1813
2 2	f/25·875	41·84	7	f/63	248·06	11	f/99	612·56	15	f/135	1139·06	19	f/171	1827·56
3	f/27	45·5	7 3	f/64·125	257	11 3	f/100·125	627	15 3	f/136·25	1158	19 3	f/172·125	1851
3 3	f/28·125	49·43	7 3	f/65·25	266	11 3	f/101·25	641	15 3	f/137·25	1177	19 3	f/173·25	1875
3 3	f/29·25	53·48	7 3	f/66·375	275	11 3	f/102·275	653	15 3	f/138·375	1197	19 3	f/174·375	1900
3 3	f/30·375	57·79	7 3	f/67·5	284·76	11 3	f/103·5	669·51	15 3	f/139·5	1216·26	19 3	f/175·5	1925·01
3 3	f/31·5	62·01	7 3	f/68·625	295	11 3	f/104·625	684	15 3	f/140·625	1236	19 3	f/176·625	1950
3 3	f/32·725	66·36	7 3	f/69·75	304	11 3	f/105·75	699	15 3	f/141·75	1256	19 3	f/177·75	1975
3 3	f/33·75	71·19	7 3	f/70·875	314	11 3	f/106·875	713	15 3	f/142·875	1276	19 3	f/178·875	2000
3 3	f/34·875	76·01	8	f/72	324	12	f/108	730	16	f/144	1296	20	f/180	2025
3 3	f/36	81	8 3	f/73·125	335	12 3	f/109·125	744	16 3	f/145·125	1317			
4	f/37·125	86·14	8 3	f/74·25	345	12 3	f/110·25	760	16 3	f/146·25	1337			
4 4	f/38·25	91·44	8 3	f/75·375	356	12 3	f/111·375	775	16 3	f/147·375	1357			
4 4	f/39·375	96·89	8 3	f/76·5	366·76	12 3	f/112·5	791·01	16 3	f/148·5	1378·26			
4 4	f/40·5	102·51	8 3	f/77·625	377	12 3	f/113·625	807	16 3	f/149·625	1400			
4 4	f/41·625	108·39	8 3	f/78·75	388	12 3	f/114·75	823	16 3	f/150·75	1421			
4 4	f/42·75	114·22	8 3	f/79·875	399	12 3	f/115·875	839	16 3	f/151·875	1442			
4 4	f/43·875	120·31	9	f/81	410·06	13	f/117	855·56	17	f/153	1463·06			
5	f/45	126·56	9 3	f/82·125	422	13 3	f/118·125	872	17 3	f/154·125	1484			
5 5	f/46·125	132·96	9 3	f/83·25	433	13 3	f/119·25	888	17 3	f/155·25	1506			
5 5	f/47·25	139·56	9 3	f/84·375	445	13 3	f/120·375	904	17 3	f/156·375	1528			
5 5	f/48·375	146·25	9 3	f/85·5	456·89	13 3	f/121·5	922·64	17 3	f/157·5	1550·39			
5 5	f/49·5	153·14	9 3	f/86·625	469	13 3	f/122·625	940	17 3	f/158·625	1572			
5 5	f/50·625	160·18	9 3	f/87·75	481	13 3	f/123·75	957	17 3	f/159·75	1595			
5 5	f/51·75	167·37	9 3	f/88·875	493	13 3	f/124·875	974	17 3	f/160·875	1618			
5 5	f/52·825	174·735	10	f/90	506·25	14	f/126	992·25	18	f/162	1640·25			
5 5	f/54	182·25	10 3	f/91·125	519	14 3	f/127·125	1010	18 3	f/163·125	1662			
6	f/55·125	189·99	10 3	f/92·25	532	14 3	f/128·25	1028	18 3	f/164·25	1685			
6 6	f/56·25	197·75	10 3	f/93·375	545	14 3	f/129·375	1046	18 3	f/165·375	1708			
6 6	f/57·375	205·74	10 3	f/94·5	558·14	14 3	f/130·5	1064·38	18 3	f/166·5	1732·64			
6 6	f/58·5	213·89												

The U. S. numbers for whole and half magnifications in this table are correct to two places of decimals. The intervening values are sufficiently accurate, the margin of error in no case exceeds one per cent.

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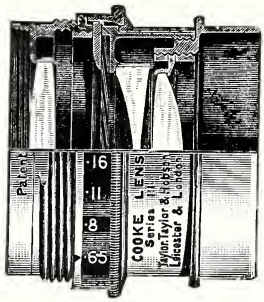

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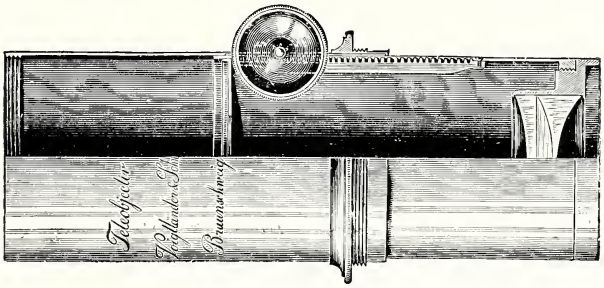

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11	8½ × 6½	1¾	2·1	7 15 0	2/-
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16	12 × 10	2½	2·8	15 0 0	2/6
18	15 × 12	3	3·3	18 10 0	3/-
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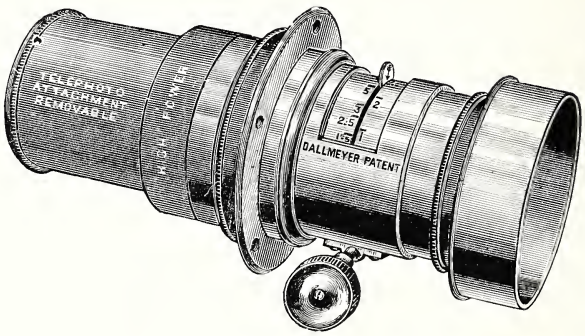
I. HIGH POWER.

Consisting of a Portrait Lens and a high power negative of about one-fourth the focus of Portrait Lens.



	Mounted in Brass. £ s. d.	Mounted in Aluminium. £ s. d.
No. 1. PATENT STEREO LENS, with Iris Diaphragms, and No. 1 Negative (1·6in. focus)	7 15 0	9 5 0
No. 2. 1 B PATENT PORTRAIT LENS, with Iris Diaphragms, and No. 2 Negative (1·8in. focus)...	11 10 0	13 7 6
No. 3. 2 B PATENT PORTRAIT LENS, with Iris Diaphragms, and No. 3 Negative (2·4in. focus)...	18 17 6	21 2 6

The negative elements alone can be adapted to any existing Patent Stereo, 1 B or 2 B Patent Portrait Lenses, at the following prices:

		£ s. d		£ s. d.
No. 1. NEGATIVE ...	In Brass	2 15 0	In Aluminium	3 5 0
„ 2. „ ...	„	3 15 0	„	4 7 6
„ 3. „ ...	„	4 17 6	„	5 12 6

II. MODERATE POWER.

Consisting of a Portrait Lens and a moderate power negative of about half the focus of Portrait Lens.

	Mounted in Brass £ s. d.	Mounted in Aluminium. £ s. d.
No. 1.* PATENT STEREO LENS, with Iris Diaphragms, 2½in. focus negative ...	8 10 0	10 0 0
No. 2. 1 B PATENT PORTRAIT LENS, with Iris Diaphragms, and 3in. focus negative	11 5 0	13 2 6
No. 3. 2 B PATENT PORTRAIT LENS, with Iris Diaphragms, and 4in. focus negative	18 5 0	20 10 0

The negative elements alone can be adapted to any existing Patent Stereo, 1 B or 2 B Patent, or similar Portrait Lenses, at the following prices:

		£ s. d.		£ s. d.
2½in. NEGATIVE ...	In Brass	3 10 0	In Aluminium	4 0 0
3in. ,, ..	,,	3 10 0	,,	4 2 6
4in. ,, ...	,,	4 5 0	,,	5 0 0

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COMBINATION OF I. AND II.

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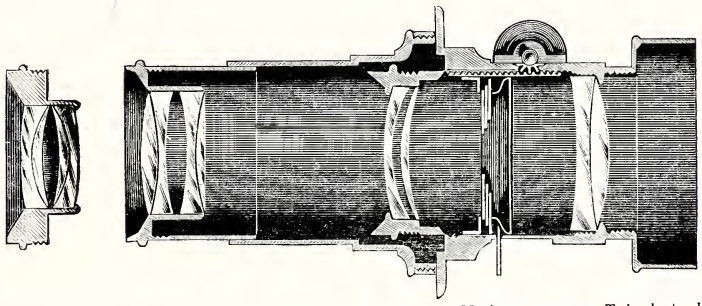

High-power Negative. Moderate-power Telephoto Lens

* "Telephotographic Detective Lens."

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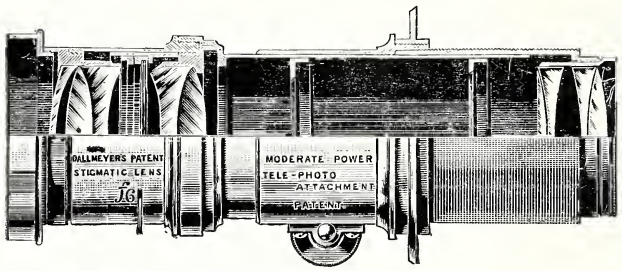
No. 1 PATENT STEREO LENS, with Iris Diaphragms, and a high and moderate power Negative Element	10 15 0	12 5 0
No. 2. 1 B PATENT PORTRAIT LENS, with Iris Diaphragms, and a high and moderate power Negative Element ...	14 10 0	16 7 6
No. 3. 2 B PATENT PORTRAIT LENS, with Iris Diaphragms and a high and moderate power Negative Element ...	22 12 6	24 17 6

III. MODERATE POWER.

Consisting of an R.R. Lens and a moderate power Negative of about half its focus.



The prices of the Negative Elements alone are here given. As the Positive Element, either the "Rapid Rectilinear" or the "Stigmatic" may be employed. Zeiss, Goerz, Cooke, or other Anastigmats also form admirable positive elements.

Focus of Negative Element ..	2½in.	3in.	4in.	5in.	6in.	7in.	8in.	10in.	12in.
Diameter .. .	1in	1¼in.	1½in.	1¾in.	2in.	2¼in.	2⅜in.	2⅝in.	3in.
	£ s.	£ s.	£ s.	£ s	£ s.	£ s.	£ s.	£ s.	£ s.
Price, with Rack and Pinion Movement in Brass ..	3 15	3 15	4 10	5 5	6 0	7 0	8 10	11 0	14 0
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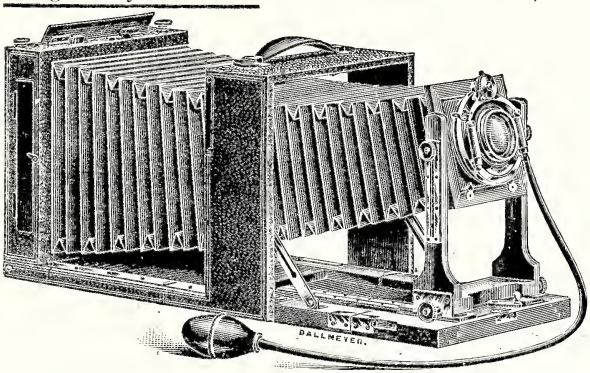

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No.	Price. £ s. d.	Code Word.
III.	5 0 0	Ration
IV.	9 0 0	Ratte

TELE-POSITIVE 1 : 3.*

No.	Diameter of Lenses. mm.	Focus. mm.	Price. £ s. d.	Code Word.
1	45	135	6 15 0	Raffinade
2	75	225	20 0 0	Raphael
3	125	375	50 0 0	Reaction

TELE-NEGATIVE 1 : 2.

No.	Diameter of Lenses. mm.	Focus. mm.	Price. £ s. d.	Code Word.
1	15	27	2 0 0	Realitas
2	24	45	2 10 0	Record
3	30	58	3 10 0	Regulus
4	37	75	5 0 0	Remedium
5	50	100	7 10 0	Reptilia
6	63	125	11 0 0	Relais

* The Tele-positives must not be imported into France commercially.

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of Tele-photographic Combinations adapted for Tube-mount IV.

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1*	Tele-Pos. 1 : 3	135	45	14 5 0	Resonator	Landscapes and large Portraits	Tele-Pos. 1 : 3	225	75	34 0 0	Rubin	1*
2*	Tele-Pos. 1 : 3	135	58	15 5 0	Retina		Tele-Pos. 1 : 3	225	100	36 10 0	Rubrik	2*
3	Anast. 1 : 8	205	58	16 10 0	Rosmarin	Landscapes and Architectural Views.	Anast. 1 : 8	350	100	35 0 0	Rumor	3
4	Anast. 1 : 8	196	75	15 5 0	Ro-so		Anast 1 : 8	433	125	43 10 0	Rundung	4
5*	Satz-Anast 1 : 7	179	58	19 10 0	Rotator		Anast. 1 : 8	407	125	35 10 0	Rune	5
6*	Satz-Anast. 1:6·3	200	75	22 0 0	Rubens		Satz-Anast. 1:6·3	337	100	44 0 0	Russe	6*
7*	Satz-Anast 1 : 7	216	75	23 15 0	Ruptura		Satz-Anast. 1 : 7	364	125	51 15 0	Ruthene	7*

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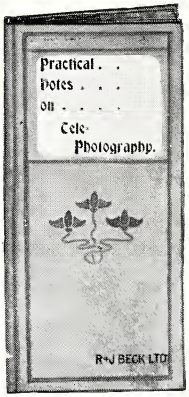

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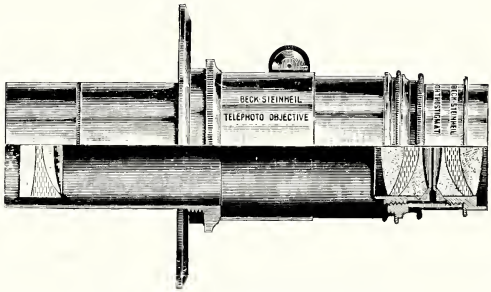

TABLE I.—HIGH POWER.

No.	Negative Element.	Suitable for Lens of Foci.	For Beck-Steinheil Orthostigmats.	Price. £ s. d.
1	No. I.	7in. to 9in.	Nos. 5, 5a, 4a, 4b, 6,	4 15 0
2	,, II.	9in. ,, 12in.	7, and 8.	5 10 0

STANDARD POWER.

No.	Negative Element.	Suitable for Lens of Foci.	For Beck-Steinheil Orthostigmats.	Price. £ s. d.
1	No. I.	4in. to 5½in.	No. 2a, 2b, 3, 3a	4 0 0
2	,, II.	5in. ,, 6½in.	,, 3b, 4, 4a	4 0 0
4	,, II.	6in ,, 8in.	,, 4b, 5, 5a	4 15 0
5	,, IIa.	8in. ,, 9½in.	,, 6	5 10 0
6	,, III.	9in. ,, 10½in.	,, 7	6 0 0
7	,, III.	10in. ,, 13in.	,, 8	7 0 0
8	,, IV.	13in. ,, 15in.	,, 9	8 0 0

LOW POWER.

No.	Negative. Element.	Suitable for Lens of Foci.	For Beck-Steinheil Orthostigmats.	Price. £ s. d.
1	No. I.	3in. to 4½in.	No. 1, 1a, 1b, 2	4 0 0
2	,, II.	4½in. ,, 6in.	,, 3, 3a, 3b	4 10 0
3	,, IIa.	6in. ,, 7in.	,, 4, 4a	5 0 0
4	,, III.	7in ,, 8½in.	,, 4b, 5, 5a	6 0 0
5	,, IV.	8½in. ,, 11in.	,, 6, 7, 8	7 5 0

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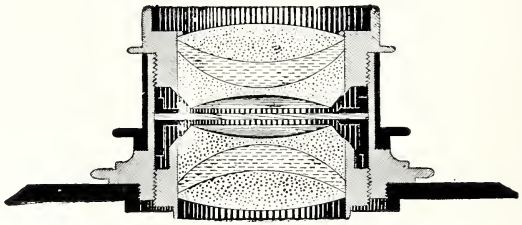
Beck-Steinheil Orthostigmat.

SERIES I. F/6·3.

See Lens List for full Particulars.



Beck-Steinheil Orthostigmat, No. 3. Full size.

TABLE III.

No. oc. to f/6·3, No. 6·9 f/6·8

No.	Oc	1	2	3	4	5	6	7	8	9
Aperture.	$\frac{1}{2}$ in.	$\frac{9}{16}$ in.	$\frac{5}{8}$ in.	$\frac{3}{4}$ in.	$\frac{7}{8}$ in.	$1\frac{1}{16}$ in.	$1\frac{1}{4}$ in.	$1\frac{7}{16}$ in.	$1\frac{5}{8}$ in.	$2\frac{1}{8}$ in.
Focal Length	13	14	16	18	22	27	31	36	41	53
Plate cov'd sharply at f/6·3 in.	$3\frac{1}{8}$	$3\frac{1}{2}$	$4\frac{1}{8}$	$4\frac{3}{4}$	$5\frac{15}{16}$	$7\frac{1}{4}$	$8\frac{1}{4}$	$9\frac{1}{2}$	11	$14\frac{1}{4}$
Plate cov'd sharply at f/6·3 C M	8	9	10·5	12	15	18	21	24	28	36
Plate cov'd sharply at f/22 in.	$2\frac{1}{2}$ × $3\frac{1}{2}$	$3\frac{1}{4}$ × $3\frac{1}{4}$	$4\frac{1}{4}$ × $3\frac{1}{4}$	$4\frac{3}{4}$ × $3\frac{1}{2}$	6 × 4	$6\frac{1}{2}$ × $4\frac{3}{4}$	7½ × 5	8 × 6	$8\frac{1}{2}$ × $6\frac{1}{3}$	10 × 8
Plate cov'd sharply at f/22 C M	4 × $3\frac{3}{4}$	$4\frac{1}{4}$ × $3\frac{3}{4}$	$4\frac{3}{4}$ × $3\frac{1}{2}$	5 × 4	$7\frac{1}{2}$ × $5\frac{1}{4}$	8 × 6	$8\frac{1}{2}$ × $6\frac{1}{2}$	$9\frac{1}{2}$ × 7	11 × $8\frac{1}{2}$	12 × $9\frac{1}{2}$
Plate cov'd sharply at f/45 in.	$3\frac{1}{4}$ × $4\frac{1}{4}$	$4\frac{3}{4}$ × $3\frac{1}{2}$	6 × 4	$7\frac{1}{2}$ × 5	$8\frac{1}{2}$ × $6\frac{1}{4}$	$9\frac{1}{2}$ × 7	11 × $8\frac{1}{4}$	12 × $9\frac{1}{2}$	14 × 11	16 × 16
Plate cov'd sharply at f/45 C M	8	9	10·5	12	15	18	21	24	28	36
PRICE.	£ s. d. 4 7 6	4 10 0	4 15 0	5 0 0	6 0 0	7 5 0	8 10 0	10 10 0	13 0 0	20 0 0

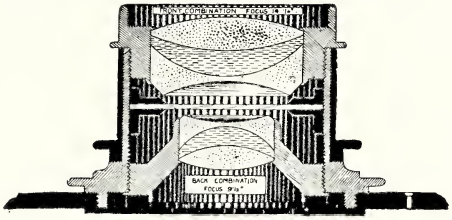
All prices are strictly nett cash.

R. & J. BECK, LIMITED, 68, CORNHILL, LONDON.

Beck-Steinheil Convertible Orthostigmat.

SERIES II. F/6·8 and F/7·7.

See Lens List for full Particulars.



Beck-Steinheil Convertible Orthostigmat. No. 3B. Sectional View.

N.B.—Larger sizes of the Convertible Orthostigmats can be quoted for on application.

TABLE IV.

No.	Focus Single Lens f/12·6.	Back	Front	Combined focus	Aperture	Suitable for Size of Plate in inches	Lenses at full ap.	At f/45	Price. £ s. d.
5a		12½	14½	7¾	f/6·8	7 × 5	8 × 5	10 × 8	8 10 0
4b		10	14⅝	7⅛	f/7·7	6½ × 4½	7 × 5	9½ × 7½	8 0 0
4a		10	12½	6½	f/6·8	6½ × 4¾	8½ × 5	9 × 7	7 0 0
3b		8½	12½	5 15/16	f/7·7	6 × 4	6½ × 4¼	8½ × 6	6 10 0
3a		8½	10	5½	f/6·8	5 × 4	6 × 4	8 × 5	5 17 6
2b		7	10	5⅛	f/7·7	5 × 4	5 × 4	7 × 5	5 15 0
2a		7	8½	4½	f/6·8	4¼ × 3¼	4½ × 3½	6½ × 4¾	5 2 6
1b		6	8½	4⅛	f/7·7	4¼ × 3¼	4 × 3½	5½ × 4¼	5 0 0
1a		6	7	3⅞	f/6·8	3½ × 3½	3½ × 3½	5 × 4	4 15 0

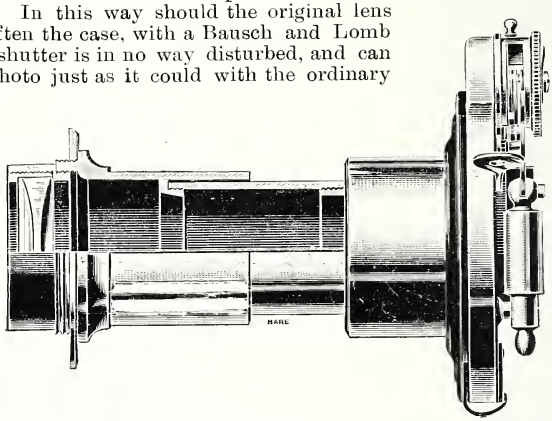
All prices are strictly nett cash.

R. & J. BECK, LIMITED, 68, CORNHILL, LONDON.

The "Bausch and Lomb" Telephoto Lens.

The idea of the makers of this lens, one of which we have now had under trial for some weeks from the wholesale agents, Messrs. A. E. Staley and Co., of 35, Aldermanbury, London, E.C , is to supply at a reasonable price a negative attachment applicable to many, if not to all, of the hand cameras of the American or folding type. At the same time they recognised the importance of doing away with the necessity for sending the positive lens to the optician to have a negative lens fitted to it, to give a telephoto combination.

Accordingly, we have in this a negative lens mounted in a tube which screws into the flange on the camera in place of the ordinary rapid rectilinear. Sliding into this tube, which is cloth-lined internally to ensure a perfectly smooth motion, is a second tube, at the end of which is a female screw identical with that on the lens flange. Into this is screwed the rapid rectilinear lens, which the negative lens in its mount has displaced, and we at once have the telephoto combination. In this way should the original lens be provided, as is so often the case, with a Bausch and Lomb type of shutter, that shutter is in no way disturbed, and can be used with the telephoto just as it could with the ordinary lens.



It is claimed for these lenses that they cover right to the corners the full size of the plate for which they are made. Certainly this was true of the specimen we have had under examination. The lens in question was fitted to a Bausch and Lomb rapid rectilinear or similar lens, as usually employed on a quarter-plate or five by four camera. With a magnification of three and a half times, and a bellows extension of ten inches or less, the circle of the image had a diameter of over eight inches. Out of every trial to which we put it the lens emerged satisfactorily, and we have considerable pleasure in commending to our readers an instrument which is worthy of the reputation of the firm that produce it, and is at the same time anything but prohibitive in price.

The lens is made in three series, A, B, and C, for use with rectilinear lenses of various focal lengths and cameras of different bellows extension, at prices from forty to fifty-seven shillings and sixpence.—*Photography*, March 7th, 1901.

Since this article was written this firm has put upon the market a complete series of high power Tele Lenses amplifying from three to eight times for the usual Rapid Symmetrical Lenses, also for the special anastigmat lens of various makers of 4¾in. to 9½in. foci.

Full particulars of these will be found in the following pages. Price lists may be obtained of all dealers and photo stores.

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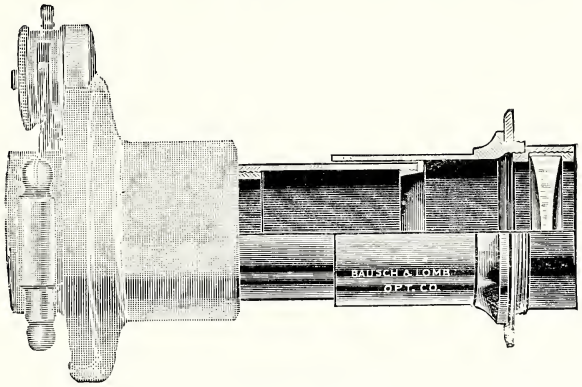
A. E. STALEY & CO., 35, Aldermanbury, London, E.C.

TELEPHOTO LENSES (BAUSCH AND LOMB).



Achromatic Negative Combinations.

FOR USE ON UNICUM SHUTTERS OR LENSES.

Negative attachments only giving two to four magnifications.

For ... ... Diameter of Lens ... ... Suitable for Lenses from ..	5 × 4 Shutter. 26 mm. 5½ × 6in. focus	7 × 5 34 mm. 9 focus	9 × 7 43 mm. 11½ focus	Suitable for Tele Lens.
	40/-	45/-	50/-	

These will suit the usual English, French, or German Lenses of aperture f/6 or f/8, etc.
Rack and Pinion Adjustment 10/- extra.
When not fitted to Unicum Shutter, Adapters are required.

PRICE LIST.

In order to make these lenses of universal application, we have constructed them in three series, A, B and C, for use with photographic lenses of various equivalent foci and cameras of different bellows length.

Each lens is supplied in compact leather case.

The Hand Camera Telephotos are constructed for use with the regular rectilinear lenses supplied with cameras by the manufacturers.

Telegraphic Code	Size.	Series.	Approximate Focus of Photo lens.	Bellows Length, 2½ Magnification.	For cameras mentioned and others having as much bellows length.	Price
			in.			
	4¼ × 3¼		5½	6		40/-
Telhaba.	4 × 5	A	6¾	9¼		40/-
Telhaco.	*5 × 7	A	8½	13¾	Premo.	45/-
Telhader.	*6¼ × 8½	A	10½	15		50/-
Telhaef.	4 × 5	B	6	8¼	Poco, Monroe, Ray, Mon-	40/-
Telhafar.	5 × 7	B	7⅝	12	tauk, Ascot, Graphic,	45/-
Telhagon.	*6½ × 8½	B	10½	15	Glencoe, Wizard, Vici.	50/-
Telhaha.	†4 × 5	C	6	7½	Kodak.	40/-
Telhaima.	5 × 7	C	8½	9½		57/6

† Pictures of the above size will trim slightly smaller.

Hand Camera Telephoto fitted to Anastigmat and other types of lenses, 17/6 extra. As these lenses are usually of considerably shorter focus than the R.R. and symmetrical lenses for which the Hand Camera Telephoto is designed, the image circle will not quite cover the plate for which the anastigmat is rated, except at the higher magnification

Adapters for lenses not having standard screw, 6/6.

In this list the *5 × 4 and *7 × 5 sizes fit the 5 × 4 Unicum shutter, the *8½ × 6½ are intended for the 8 × 5 Unicum as fitted to American-made cameras, for larger diameter negative attachments see

Price List of all Dealers and Photo Stores.

Wholesale Importers: A. E. Staley and Co., 35, Aldermanbury, London, E.C.

TELEPHOTO LENSES (BAUSCH AND LOMB).

(Complete with Rapid Symmetrical Combinations f/8, and UNICUM Shutters).

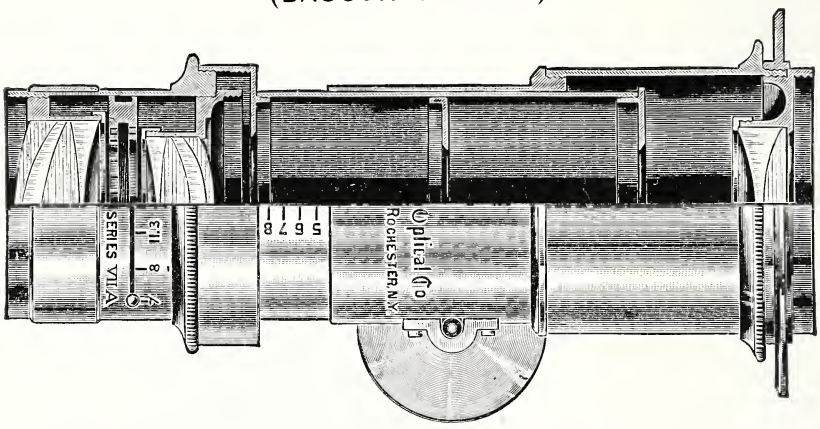
Focus of Positive Lens	Quarter-plate 5 x 4 Unicum 5½ x 6 dia. 26 mm.	5 x 4 5 x 4 7½ 26 mm.	6½ x 4¾ 8 x 5 9 34 mm.	8½ x 6½ 9 x 7 11½ 42 mm.
	75/-	85/-	95/-	112/6

The above have amplifying power of from two and a half to three and a half times, according to length of camera extension.

Rack and pinion adjustments, 10/- extra.

TELEPHOTO LENSES, Best Quality

(BAUSCH & LOMB).



Complete with Rapid Sym. Lens and Unicum Shutters, with Rack and Pinion focussing adjustment, High Power three to eight magnification.

Plate covered	Quarter-plate 5 x 4 shutter	5 x 4 5 x 4 shutter	7 x 5 5 x 4 shutter	7 x 5 7 x 5 shutter	9 x 7 9 x 7 shutter
Focus of Lens ...	5½ x 6in.	7½in.	and 8in. R.S. Lens.	and 9in. R.S. Lens.	and 12in. R.S. Lens.
	110/-	115/-	127/6	137/6	167/6
Tele Attachment only	67/6	78/6	78/6	78/6	85/-

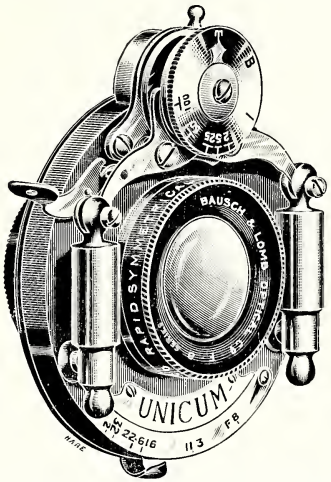
Special Negative Attachments for anastigmats and other rapid lenses, 6, 6½, 8, and 9½in. focus, suitable for lenses in mountings 1½in. to 2in. diameter of male thread. Adaptors, 2/6 each.

N.B.—With high-power telephoto lenses the lower amplification of three times does not quite cover plate. To cover plate use four times and upwards.

Price list of all Dealers and Photo Stores.

Wholesale Importers: A. E. Staley & Co., 35, Aldermanbury, London, E.C.

UNICUM SHUTTERS



Complete with Rapid Rectilinear Lenses or Best Rapid Symmetrical Lenses f/8 of finest quality selected for Detective and other Hand Cameras.

Hand Camera	¼-p. and 5 × 4	6½ × 4¾	8½ × 6½
Dia. of Lens	26 mm.	34 mm.	42 mm.
Focus Equivalent	5½ and 6in.	9	11½
Rapid Rectilinear	33/-	42/-	70/-
Best quality R. Symmetrical ...	42/-	57/6	82/6

Special quotations to Manufacturers of Hand Cameras for quantities of 100 or 1,000 Shutters, or Shutters and Lenses. These Lenses are beautifully finished, of guaranteed quality, the cells being oxidised with full description and focus engraved thereon and filled in in white, giving style and finish. Thousands of these have been fitted and given perfect satisfaction on the most popular Hand Cameras on the Market.

Upwards of 250,000 of the above have been supplied to the Trade.

APPROXIMATE TABLE FOR TELEPHOTO LENSES,

Showing extension of camera required and amplification.

Equivalent Foci of Positive Lens	2½	Amplification. 3	3½	4		Focus of Tele Negative Lens.
For Plates		Bellows Extension.				
3¼ × 4¼	5½	6	7¾	9½	11½ inches.	3⅝ in.
5 × 4	6	8	10¼	12½	15 ,,	5 ,,
5 × 4	7½	10½	13½	17	19½ ,,	6¾ ,,
½	9	12	15	18	22 ,,	8 ,,
1/1	11½	17½	22	27	32 ,,	10½ ,,

HIGH-POWER TELEPHOTO LENSES.

Magnification.

Focus of Photo Lens 6	3	4	5	6	7	8 times	Extension of Camera or distance between Negative Lens and ground glass
6½	6½	9¾	13	16¼	19½	22¾ inches	
8	8	12	16	20	24	28 ,,	
9	9	13½	18	22½	27	31½ ,,	
9½	9½	14¼	19	23¾	28½	33¼ ,,	

Diameter of Image Circle.

For	Focus of Lens.				
¼	5½	5½	6¾	8	10 inches.
5 × 4	6	6½	8¼	10½	12½ ,,
5 × 4	7½	7¾	10	12¾	16 ,,
½	9	8¾	11¾	14	16¼ ,,
1	11½	12	15½	18¼	21¼ ,,

VOIGTLÄNDER & SOHN

ACTIEN GESELLSCHAFT.

ESTABLISHED 1756.

BRUNSWICK, LONDON, PARIS, and NEW YORK.

TELEPHOTOGRAPHIC LENSES

SERIES II.

Rapid, specially intended for Instantaneous and Portrait Work.

For many purposes distant views with high magnifications are required when only short exposures can be given. For these as well as Instantaneous photographs, our Series I. are not sufficiently rapid.

The Telephotographic Lenses of Series II. consist of a very rapid front lens with the large aperture f/3, in combination with a threefold single negative lens. The resulting image is perfectly flat and free from distortion, combined with brilliancy and sharp definition. A special adjustment enables the spherical aberration to be exactly corrected for each degree of magnification which may be required.

These lenses are extremely suitable for Portraiture in the Studio, and give perfect perspective, combined with good definition and covering power.

LARGER SIZES CAN BE MADE TO ORDER.

INSTRUCTIONS FOR USE ARE SUPPLIED WITH EACH LENS.

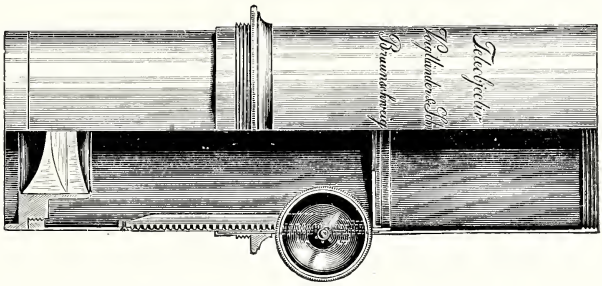
No.	Aperture.		Extension of Bellows.	Corresponding Focal Length.	Price with Iris.		
	mm.	inches.	inches.	inches.	£	s.	d.
1	53	2	6 to 30	14 to 72	18	0	0
2	66	2½	8 to 30	20 to 72	25	0	0
3	79	3	10 to 36	24 to 84	30	0	0

VOIGTLÄNDER & SOHN *(continued)*.

TELEPHOTOGRAPHIC LENSES.

SERIES I.—With Medium Rapidity.

THIS new Telephotographic Combination consists of an as perfect as possible Photographic Doublet with full aperture, at least f/8, combined with a negative lens made up of three lenses cemented together. The above combination gives a perfectly flat field with accurate reproduction of straight lines, consequently there is no distortion. The brilliancy is very little diminished owing to the negative system being cemented, thus forming a single negative lens.



PRICES.—The cost of complete Telephoto Lenses may be found by adding the cost of the Positive Lens selected to that of the Telephoto Attachment.

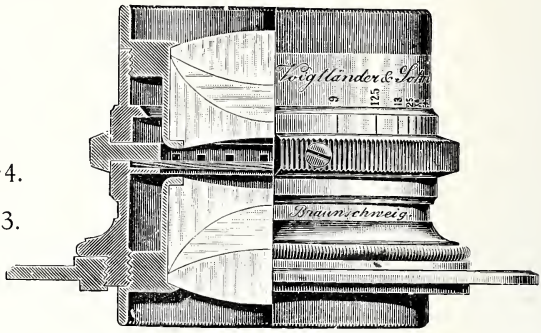
Suitable Positive Lenses.								Telephoto Attachment.			
Collinear Series II.				Collinear Series III.							
No.	Focus in Inches.	Price.			No.	Focus in Inches.	Price.				
		£	s.	d.			£	s.	d.		£	s.	d.
1	$3\frac{1}{2}$	4	16	0	1	$3\frac{1}{2}$	3	15	0	1	3	10	0
2	5	5	12	0	2	$4\frac{1}{2}$	4	10	0	2	4	0	0
3	$5\frac{7}{8}$	6	8	0	3	$5\frac{7}{8}$	5	12	0	3	4	0	0
					3a	7	7	0	0	4	4	15	0
4	$7\frac{7}{8}$	8	12	0	4	$7\frac{7}{8}$	7	12	0				
5	$9\frac{5}{8}$	11	0	0	5	$9\frac{5}{8}$	10	0	0	5	5	10	0
6	$11\frac{5}{8}$	15	0	0	6	$11\frac{5}{8}$	14	0	0	6	6	10	0
7	$14\frac{1}{2}$	20	0	0	7	$14\frac{1}{2}$	18	0	0	7	8	0	0
8	17	27	0	0	8	17	23	0	0	8	10	0	0

The Telephoto Attachments can be fitted to lenses, high-class only, by other makers. They give very good results with Cooke Lenses.

With our Tele Attachments and Collinear Lenses, definition fully equal to that of an ordinary anastigmat lens can be readily obtained.

VOIGTLÄNDER & SOHN (*continued*).

COLLINEAR LENSES.



SERIES II.

Full Aperture.

Nos. b to 4, f/5·4.

Nos. 5 to 9, f/6·3.

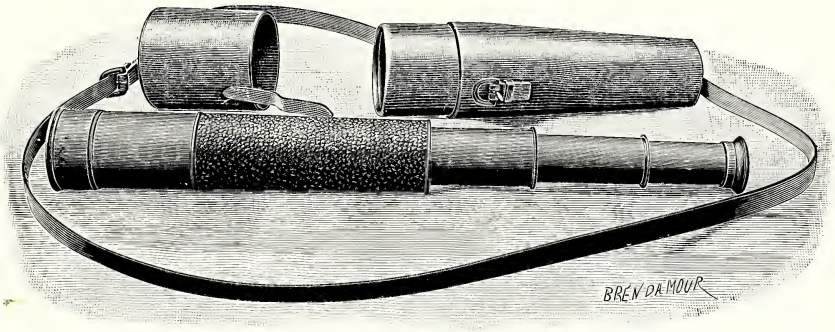
THE Collinear Lenses Series II. are symmetrically constructed anastigmats which combine the advantages of the older types of symmetrical objectives with those of the more recent anastigmats. The lenses when stopped down to f/7·7 give a sharp image of 75°. They combine with great rapidity the specific properties of the older wide-angle lenses, and are therefore very suitable for instantaneous work in the open air, also for portraits and groups in the studio. They may therefore be considered as very rapid universal lenses. The smaller sizes are specially suitable for hand cameras, and, on account of their great rapidity, f/5·4, can be used for the quickest instantaneous exposures. For stereoscopic work Nos. 2 and 3 are recommended, for near objects also No. 1. There is no extra charge for pairing. Nos. b to 00 give very good results for micro-photographic and cinematograph work.

No.	Equivalent Focus.		Size of Plate sharply covered. Full Aperture.	f/16.	f/32.	Price.	Code Word.
	mm.	in.	inches.	inches.	inches.	£ s. d.	
b	35	1½	1½ x 1½	2 x 2	2½ x 2½	3 12 0	Gabun.
c	50	2	1¾ x 1¾	2½ x 2½	2¾ x 2¾	3 12 0	Galatea.
0	61	2¼	2 x 2	2¾ x 2¾	3¼ x 3¼	3 12 0	Galen.
00	70	2¾	2½ x 3¼	2¾ x 3½	3¼ x 4	3 12 0	Galeotto.
1	92	3½	2¾ x 4	3¼ x 4	3½ x 4⅗	4 16 0	Gandara.
2	125	5	3½ x 4¾	4 x 6	4⅗ x 6¼	5 12 0	Gaston.
3	155	6	4⅗ x 6¼	5 x 7	6¼ x 8¼	6 8 0	Gawein
4	204	8	7½ x 5	8 x 6	9¼ x 7	8 12 0	Gemma
5	255	10	8¼ x 5	8¼ x 6½	9½ x 8	11 0 0	Georgia
6	307	12	8¼ x 6½	9 x 7	12 x10	15 0 0	Ginster.
7	369	14½	9 x 7	10 x 8	14 x10½	20 0 0	Gorgone.
8	445	17½	11 x 8	14 x11	20 x16	27 0 0	Gudrun.
9	525	20½	12 x10	18 x16	27 x24	34 0 0	Guntram.

Our Series III. Collinear Lenses can also be used for Telephoto Work with good results.

VOIGTLÄNDER & SOHN (*continued*).

With every telephoto outfit a telescope or field glass can be used for composing the picture.



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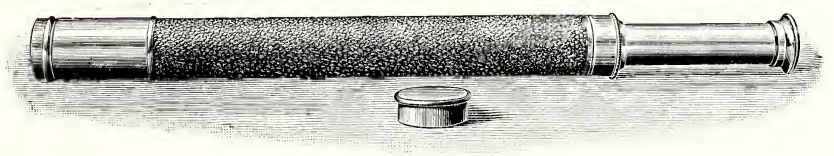
From £3 4s. each.



MARINE TELESCOPES

From £2 12s. each.

FIELD GLASSES from £3 to £12, the very best possible quality, both prismatic and Galilean types.

All information, catalogues Field Glasses, Telescopes, and Lenses post free.

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